

Chemical Engineering

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SEPTEMBER 8, 1958

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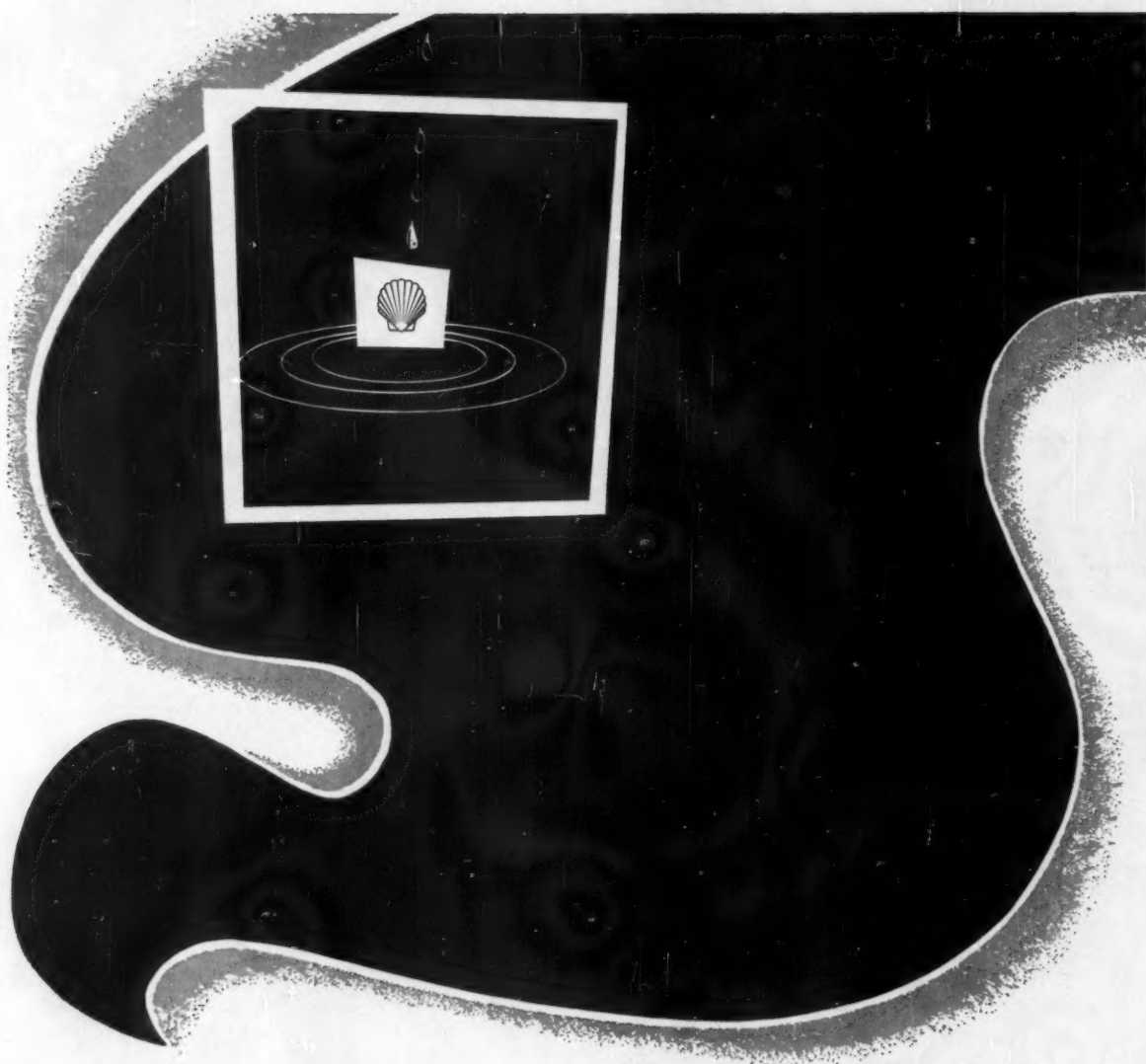
Materials
of
Construction...

NONMETALLIC INORGANICS

For Severe
Processing
Conditions

WHAT'S BEST UP TO 1500° F
NEW CHART HELPS FLOW CALCULATIONS
COSTS OF TANKS AND KETTLES

SEE
PAGE
TWO



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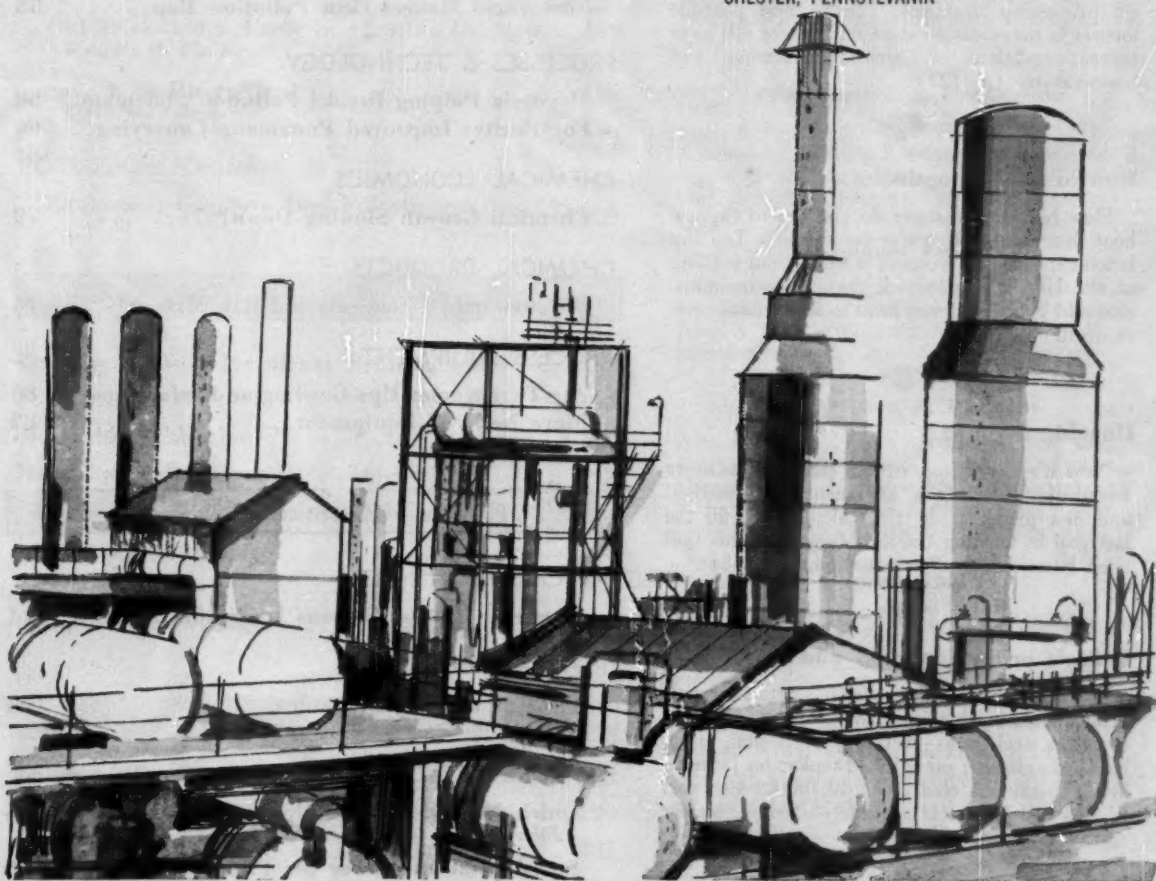
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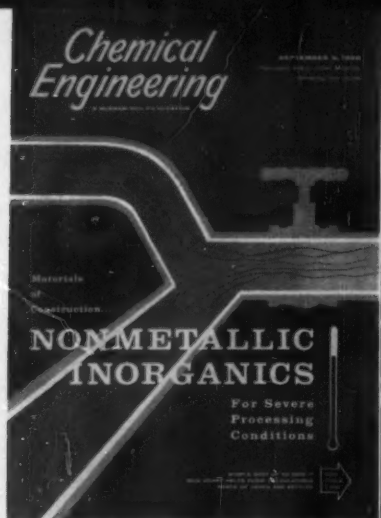
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EIGHTEENTH OF TWENTY-SIX ISSUES

18/26

New help for tough problems

Here's a comprehensive guide to all the important nonmetallic inorganics. You'll see how many are potential keys to some of your toughest processing problems. They're best possible answer in many cases—especially where you have severe conditions of corrosion, abrasion and temperature. (p. 123)



How to find the optimum

How big an exchanger do you use to capture heat that would otherwise be wasted? Too big is too expensive. Too small is worse than nothing at all. Here's how to pick the most economical size and you don't even have to know total costs to do it. (p. 135)



How big the pipe?

Now it's easier to get those fluid-flow answers when diameter is the unknown. New method and new graph slash trial calculations, fill the last gap in treating the fluid-flow problems that need Fanning's famous equation. (p. 138)



Today's prices for tanks and kettles

Your rapidly-growing cost file gets four new price curves in this issue. They'll give installed costs on steel tanks—vertical, horizontal, stainless and agitated; on agitated tanks; on jacketed kettles—stainless clad and lead lined. Also part of this installment is a guide to reducer-starter costs for agitators. (p. 141)

Chemical

SEPTEMBER 8, 1958

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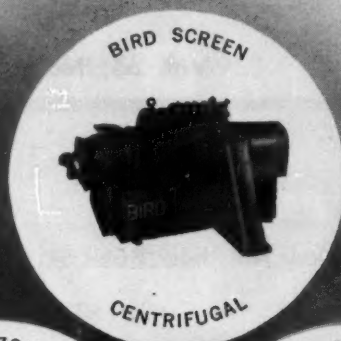
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Chemical Engineering

This issue's
top features in ...

Petrochemicals & Petroleum Refining

SEPT. 8, 1958

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This system can help you evaluate engineering effort—in small or large departments. In this issue: The job. Next issue: The man.

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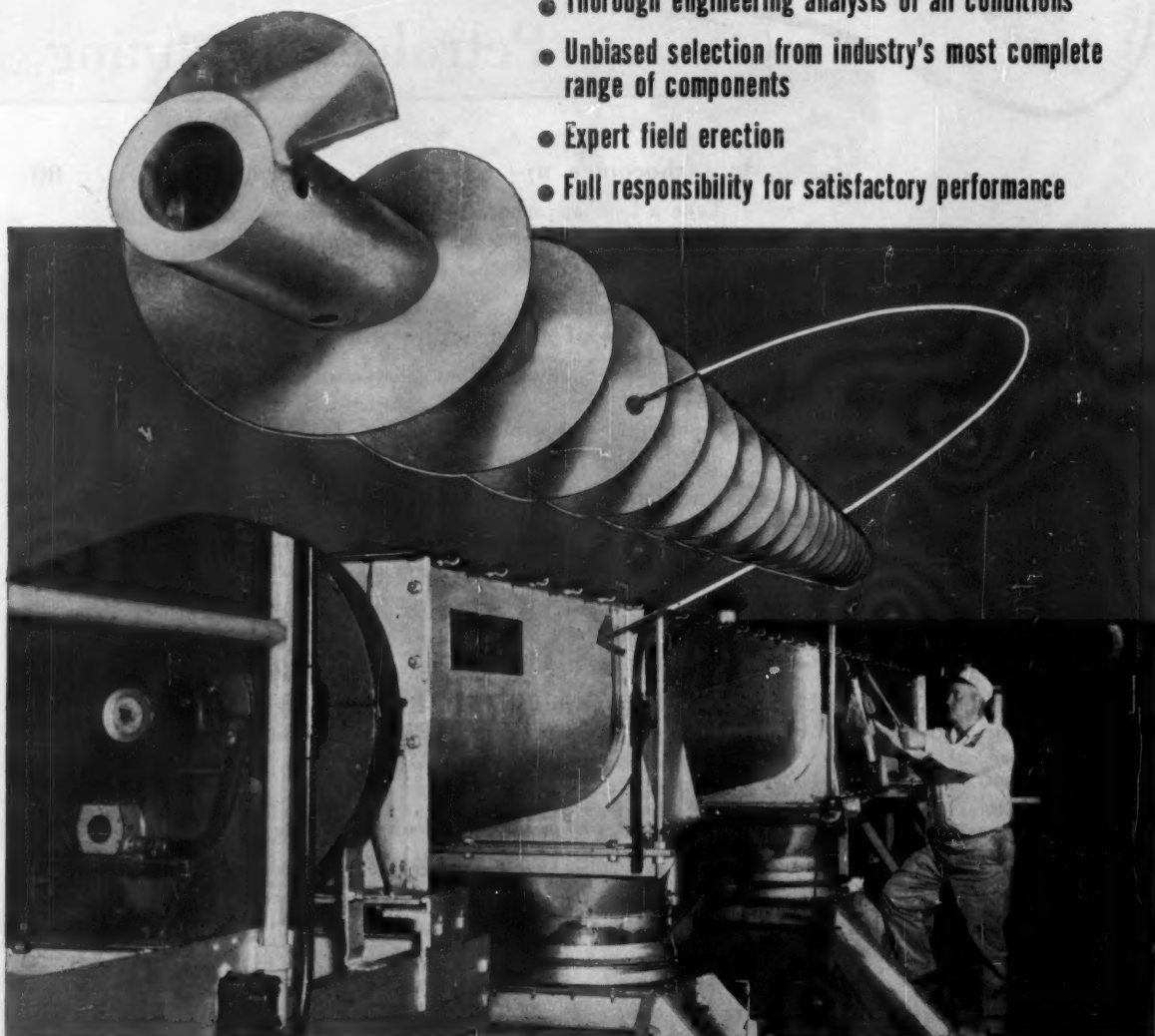
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Booth 43-44

Fletcher Works—Philadelphia will exhibit their newest 24" basket fully automatic, top drive suspended machine; a very large Tornado model, under driven, bottom discharge, with variable speed Oil-Gear drive; an all-purpose pilot plant unit. Each will be complete for demonstration operation. Many new features. Maximum centrifugal force.

Booth 45

Croll-Reynolds Company, Inc., Westfield, N. J., and Croll-Reynolds Engineering Co., 17 John Street, New York City, combine a showing of their products, with floor models, including ClaRite Filters—maximum clarification. Flexolead Expansion Joints. Steam and Water Jet equipment. Multi-stage jobs for Vacuums to low micron ranges. Chill-Vactors (vac. refrig.) Thermo-compressors, Jet Heaters, Fume Scrubbers. Con-vactors—for condensing service with NEW, water clean-up features.


Booth 46

Cornell Machine Company, 99 Wall Street, New York City, are exhibiting a commercial size Versator to mix, blend, disperse, homogenize, or emulsify one or more pumpable components with or without simultaneous deaerating, dehydrating or defoaming. High production rates—Complete Uniformity. Also used for irradiation and chemical reaction service.

Booth 47

American Heat Reclaiming Corporation, 1270 Sixth Ave., New York City, will exhibit production sizes of their well-known, full-counterflow Spiral Heat Exchanger; and an industrial type Plate Exchanger. Both are extremely compact, high-performance exchangers. Also exhibited will be a Spiral Condenser used as the top section of a fractionating or distilling column.

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General Properties

Molecular weight	102.13
Boiling point (760 mm)°C. (pure)	178
Freezing point, °C.	below -80
Refractive index (n _D)	
at 20°C.	1.4520
at 25°C.	1.4499
Specific gravity	
at 20/20°C.	1.0543
at 24/24°C.	1.0511
at 31/31°C.	1.0450
Flash point, Tagliabue, open cup, °F.	183

Thermodynamic Properties

Heat capacity, cal/g., °C.	
20-27°C.	0.424
30-37°C.	0.432
40-47°C.	0.445
Heat of combustion, cal/g. mole	
at constant volume	708.6
at constant pressure	709.5
Thermal expansion, 20-37.8°C., $\alpha \times 10^{-3}$	0.52

Fluid Properties

Viscosity, absolute, 20°C. centipoises	6.24
Surface tension, dynes/cm at 25°C.	37

Electrical Properties

Dielectric constant, 23°C.	13.6
----------------------------	------

Other Properties

Octane number	82.5
Solubility: Water, alcohol, ether, acetone, chloroform, benzene	∞
Kauri-Butanol value	71.5
Evaporation rate (n-butyl acetate=100)	7
Dilution ratio (lacquer ingredients)	4.5
Inflammability, air	
upper limit, % by vol.	9.7
lower limit, % by vol.	1.5

The Quaker Oats Company

CHEMICALS DEPARTMENT

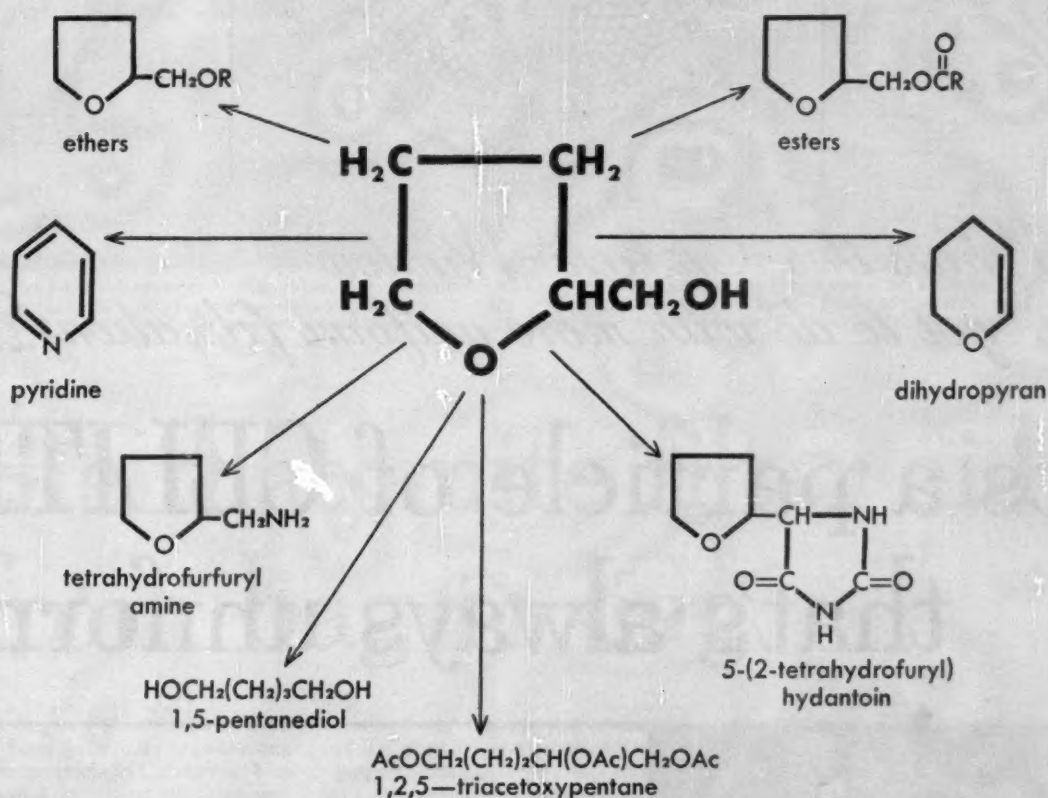
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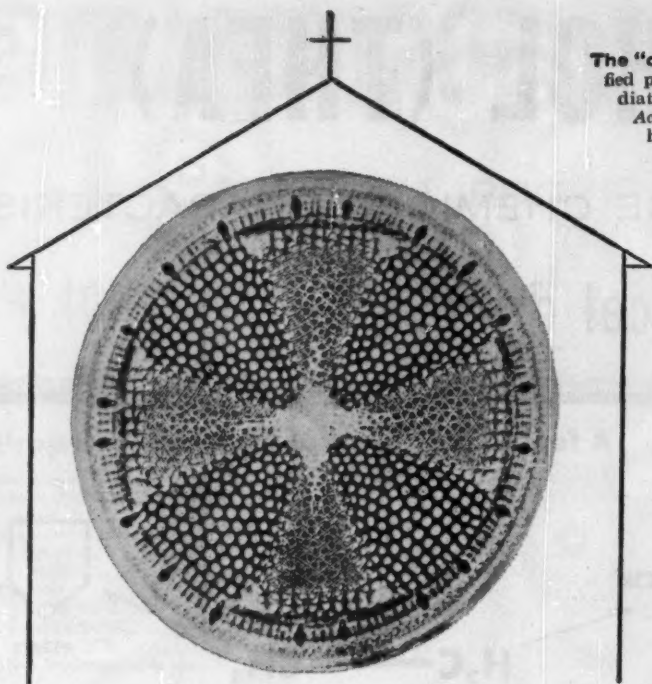
A few of the chemical reactions



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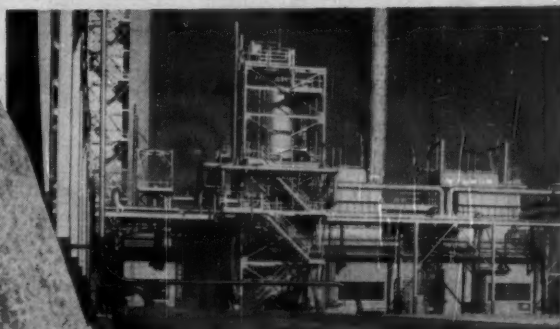
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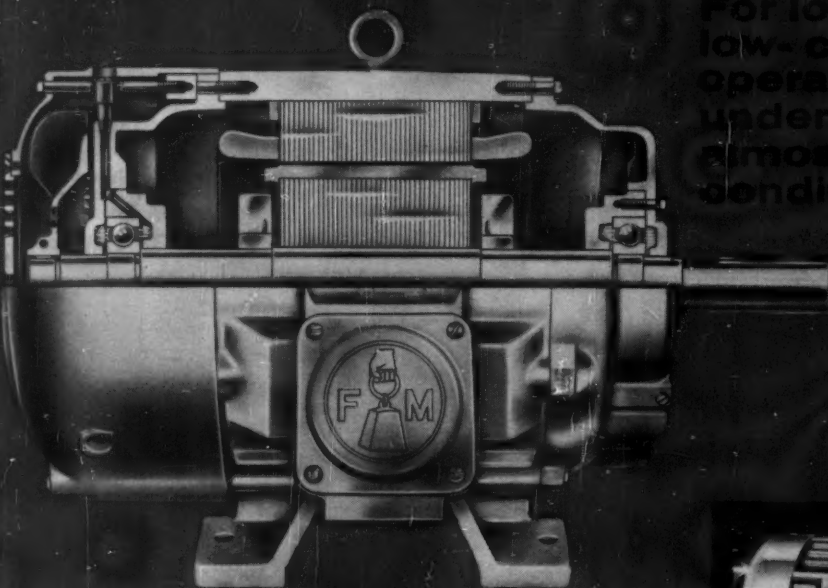
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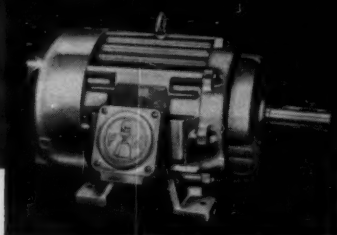
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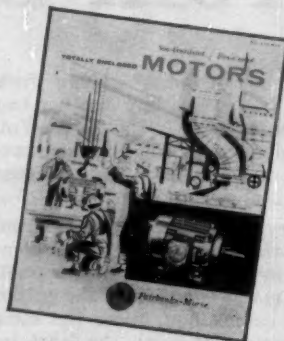
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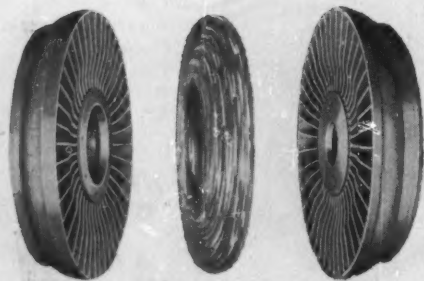
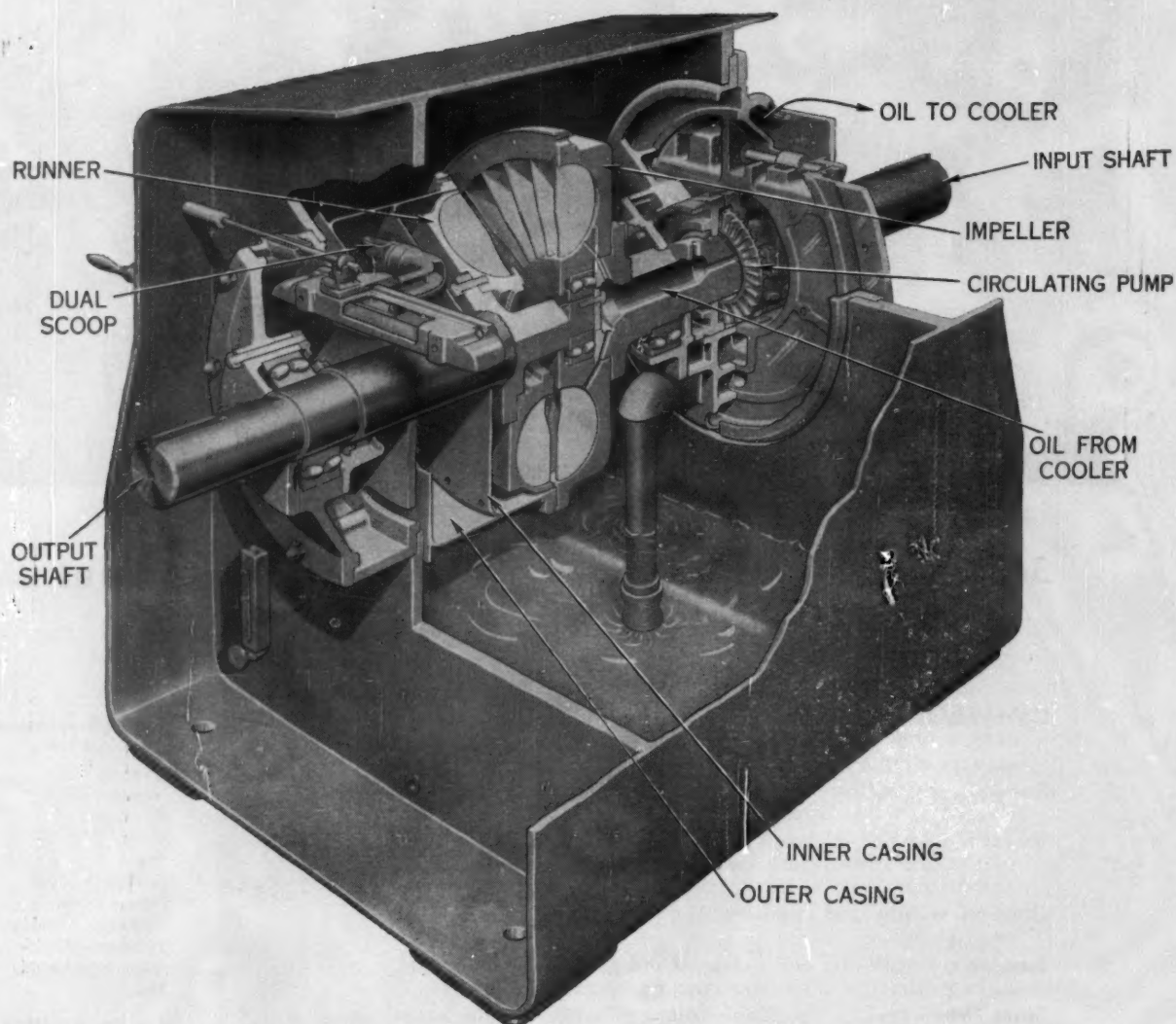
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Gýrol Fluid Drive Dept. 11-98, Detroit 32, Mich.

Please send full details on Gýrol Fluid Drive for the
following application: _____

Name _____

Title _____

Firm _____

City and Zone _____ State _____

H₂SO₄

in any concentration...

at any temperature to 500°F

can't corrode Fluoroflex®-T piping

*liner of Teflon® in thermal
equilibrium with housing*

Sulfuric, hydrochloric, nitric, hydrofluoric—any acid is harmless to Fluoroflex-T piping.

Universally inert liner. Steel pipe and fittings are lined with Fluoroflex-T... a patented, high density, non-porous compound of Teflon.

Liner and housing are in thermal equilibrium through an exclusive process developed by Resistoflex. It compensates for thermal expansion differential between the Teflon and the pipe housing, eliminating fatigue collapse, and cracking at the flange.

Solves problems, saves downtime, saves money. Type S piping installed in steam cooking process for recovering sulfuric acid from coal tar sludge at 250°F and 50 psi has been in service over a year with no maintenance difficulties.

See how Fluoroflex-T Type S piping systems can end problems of corrosion, erosion and contamination for you. Send for detailed Bulletin TS-1A. Dept. 122, RESISTOFLEX CORPORATION, Roseland, New Jersey. Other Plants: Burbank, Calif., Dallas, Tex.

© Fluoroflex is a Resistoflex trademark, reg., U. S. pat. off.
© Teflon is DuPont's trademark for TFE fluorocarbon resins

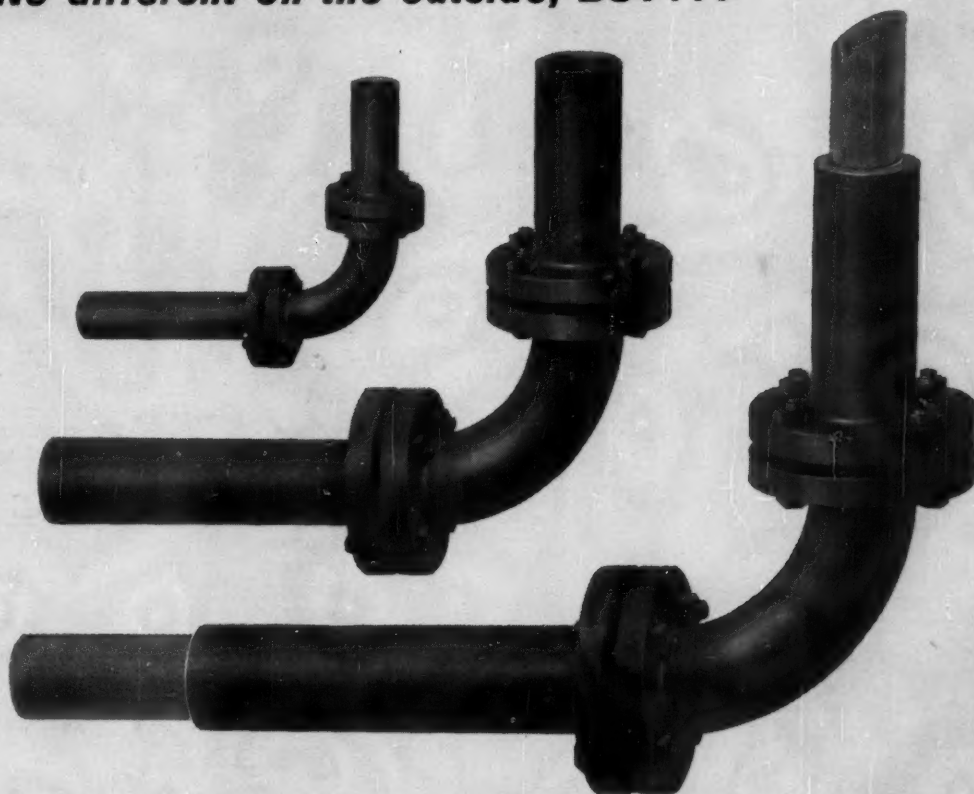
RESISTOFLEX

Complete systems for corrosive service



LINED STEEL PIPE • FLANGED FLEXIBLE HOSE • BELLOWS • ELBOWS • TEES • REDUCERS • DIP PIPES & SPARGERS • LAMINATED PIPE

No different on the outside, BUT...



**The pipe lined with a TEFLON TFE-fluorocarbon resin
will outlast all others in handling corrosives**

Here's how you can end costly pipe replacement and process shutdown . . . install pipe lined with a TEFLON TFE-fluorocarbon resin. Because TFE-fluorocarbon resins are inert to practically every known chemical, pipe lined with TFE resin stands up, even in the most corrosive services.

For example, one chemical plant installed pipe lined with TEFLON TFE-fluorocarbon resin in a service which involved exposure to boron trifluoride, hydrofluoric acid and organic acids at temperatures above 325°F. After five months of use, the pipe was inspected and found to be essentially unaffected by the rugged treatment. This proved that substantial savings could be achieved from reduced maintenance and downtime. The company also found that, because the ends of the liner are flared over the flanges, no additional gasketing was required.

Pipe linings made of TEFLON TFE-fluorocarbon resins have many other advantages. They won't shatter under vi-

bration, or physical or thermal shock, like brittle linings. They can be used at temperatures up to 500°F. Their non-adhesive properties solve cross-contamination problems. And you can now get a complete assortment of standard sizes of flanged pipe and fittings, including tees, elbows and reducers.

For greatly extended service life in chemical services, install pipe lined with TEFLON TFE-fluorocarbon resin. Check with your local supplier for the details, or, for additional technical data, write to E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 79, Du Pont Building, Wilmington 98, Delaware.

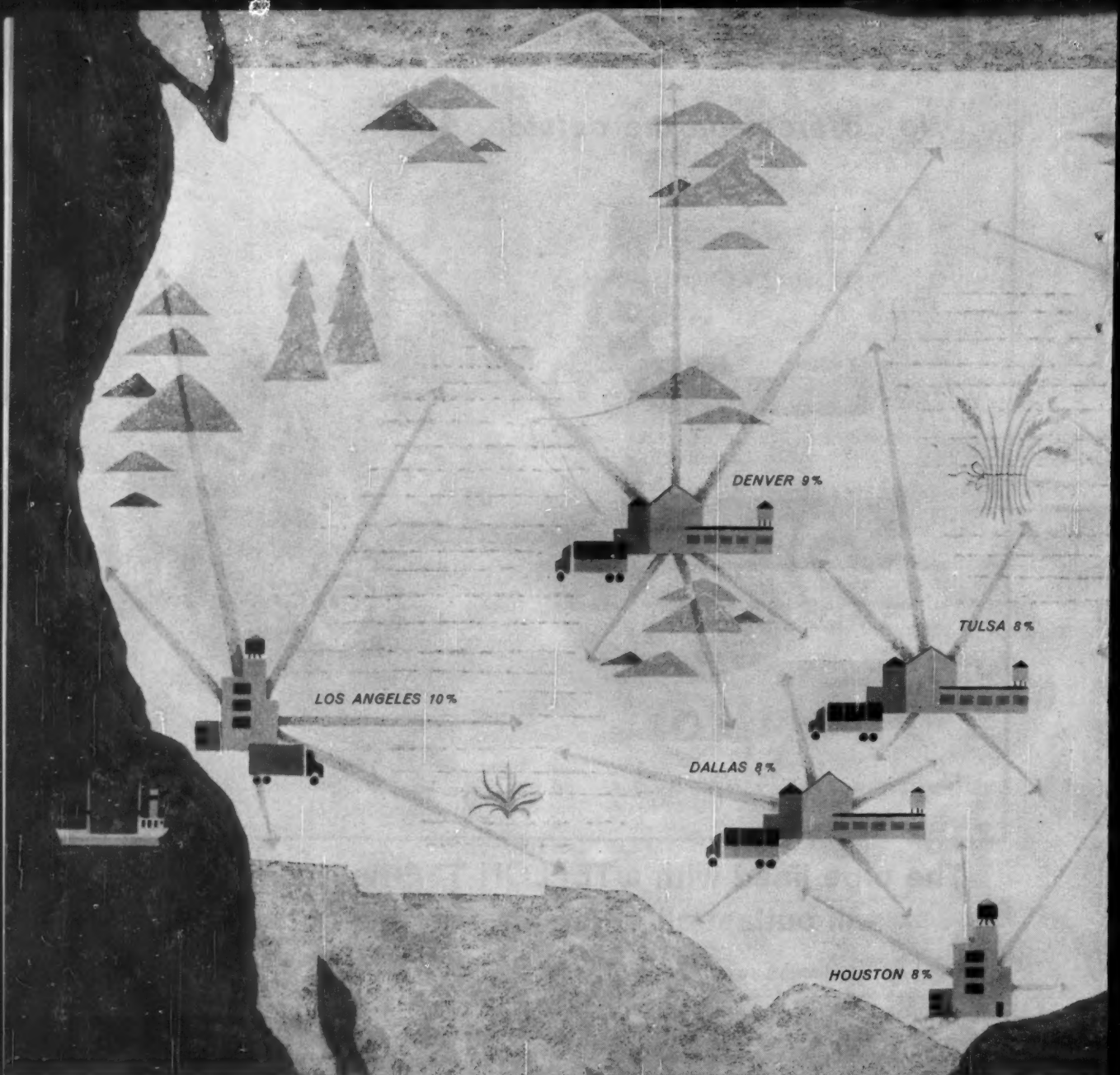
IN CANADA: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec



TEFLON®
TFE-FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY



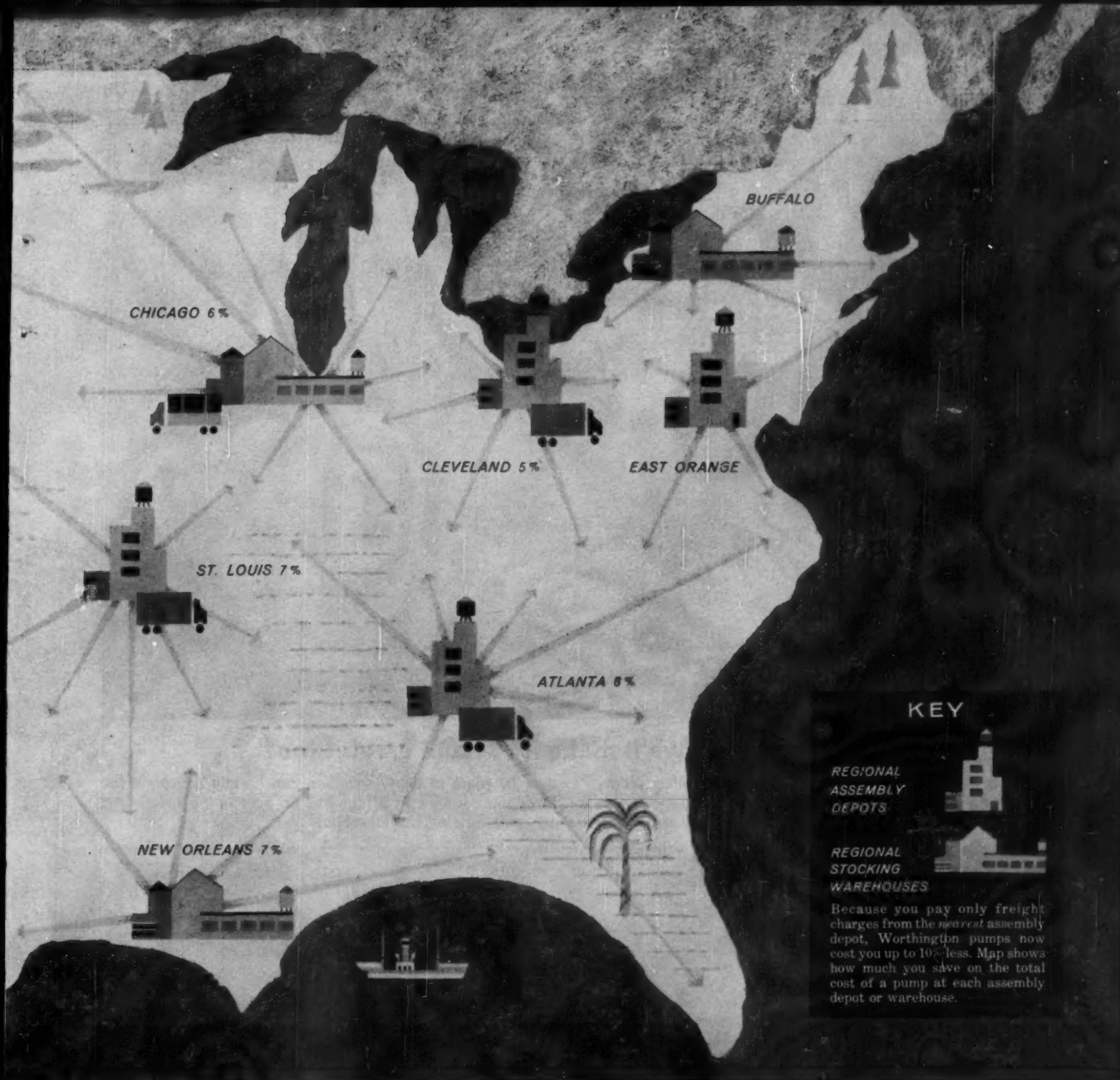
NEW SAVINGS ON

Look at the map
to see how much
less you pay!

Worthington has reduced the cost of SESC pumps by spanning the nation with *new regional assembly depots*. In addition to the primary depot in East Orange, (N.J.), others have been established in Cleveland, Atlanta, St. Louis, Houston and Los Angeles. Worthington can now pass along savings to you in three ways. One, on the price: as much as 10% depending upon your location. Two, on time—because your order can be processed and shipped in a matter of hours. Three, on parts service—because each of the assembly depots maintains a stock of spare parts.

In addition to assembly points, Worthington also maintains stocks of completely built pumps in Buffalo, Chicago, Denver, New Orleans, Dallas and Tulsa.

But there are other reasons why SESC (standard end



WORTHINGTON PUMPS

suction centrifugal) is far and away your best pump buy. Standardization gives you a high degree of interchangeability. Pumps may be all iron, all bronze, standard fitted, or Worthite*. 120 different sizes, with open or closed impellers are available with capacities up to 2700 GPM and heads to 550 Ft. Conventionally packed boxes or mechanical seals are optional in all pumps, and conversions from packed boxes to seals may be made on units in the field. All in all there are 70,480 modifications of the SESC pump to choose from—the broadest combination the pump industry has to offer.

SESC pumps also give you these benefits of standardization. You can cut your spare parts inventory by 50% because only four bearing frame sizes are used for the entire 120-pump line, and all pump parts are interchange-

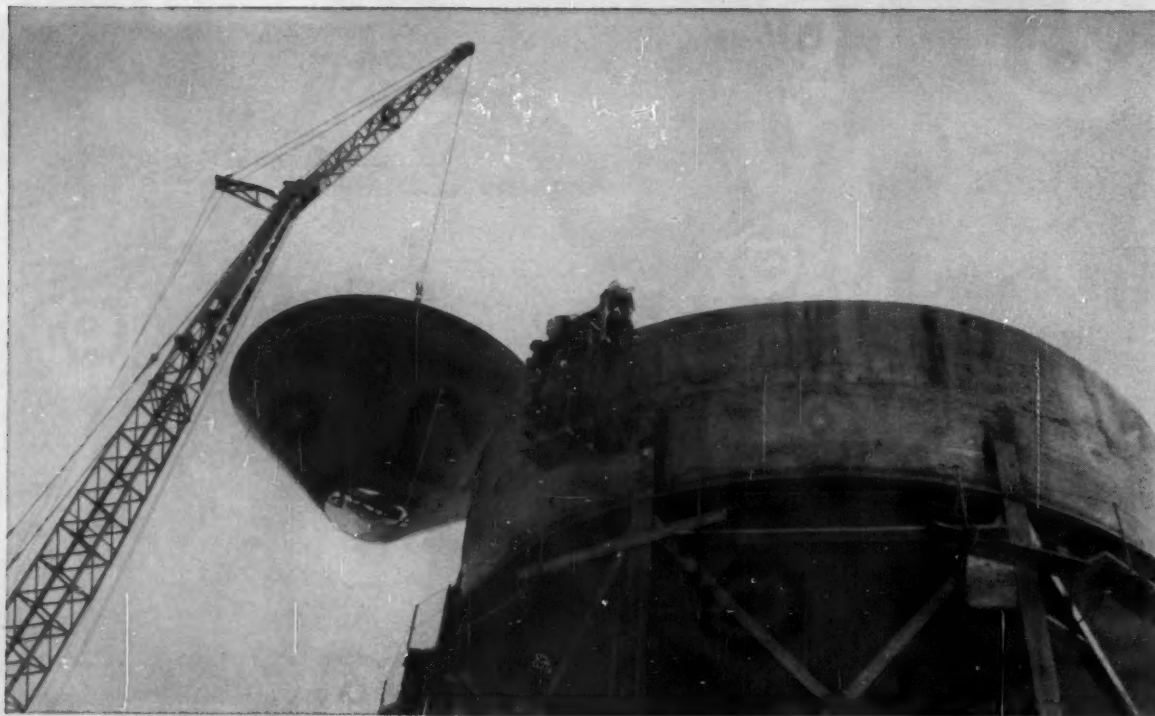
able. This means reduced downtime if repair or conversion is made. Finally, one basic design for the complete line simplifies maintenance and lowers overall operating costs.

Take advantage of the new low costs—the speeded delivery—the many outstanding features of the Worthington SESC line now. For detailed information, write for Bulletin W-300-B48. Worthington Corporation, Section 20-3, Harrison, New Jersey. In Canada: Worthington, Ltd., Brantford, Ontario.

*Worthite is a high nickel, high-chromium, low-carbon alloy steel. Trademark Reg. U. S. Pat. Off.

WORTHINGTON

Ready now at Orange, Texas



You name it . . . we'll make it . . . and erect it too!

Anything American Bridge fabricates, it can also erect. Possessing the most complete range of construction equipment in the industry and skilled personnel backed by

over 50 years of experience, we can handle any plate job anywhere. American Bridge has no peer in the specialized business of steel construction.



BIG EQUIPMENT for important jobs. The modernized plate fabricating shop is a two-aisle building, 177' wide and 750' long, with extended crane runways, 270' and 200' lengths at either end. The heavy aisle is furnished with two 50-ton, one 15-ton and one 10-ton crane and the light aisle has one 25-ton, one 15-ton and one 10-ton crane.

modern fabricating facilities for Top-quality plate work of all kinds

Tanks • Pressure Vessels • Stacks • Bins • Pipe

To better accommodate the growing needs of the dynamic industries of the South and Southwest, our Orange, Texas, plant has been completely modernized, enabling us to handle literally any type and size of plate work—including heavy wall pressure vessels for the petroleum, chemical, paper and other industries.

Plate fabricating facilities include large car bottom-heating and stress-relieving furnaces, high-capacity bending rolls, a variety of presses and press brakes, the latest in welding and X-raying equipment, high-capacity plate shears, edge planers, boring mills and drills.

The plant, strategically situated to serve the industries of the South and Southwest promptly

and economically by rail, truck or water, is also designed for fast, efficient material handling. It is equipped with 7 cranes capable of lifting over 100 tons.

American Bridge also offers complete construction service. We have the experience, manpower and equipment to handle any plate construction work efficiently and economically.

Our Orange plant is ready to serve you now. Specialists at Orange and all other American Bridge Contracting Offices around the country are prepared to discuss your plate requirements. For high-quality, economical plate work, just get in touch with the nearest office.

USS is a registered trademark

Write for our new booklet completely describing facilities and services

General Offices: 525 William Penn Place, Pittsburgh, Pa. Contracting Offices in: Ambridge • Atlanta • Baltimore • Birmingham • Boston • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Elmira • Gary • Houston • Los Angeles • Memphis • Minneapolis • New York • Orange, Texas • Philadelphia • Pittsburgh • Portland, Ore. • Roanoke • St. Louis • San Francisco • Trenton • United States Steel Export Company, New York

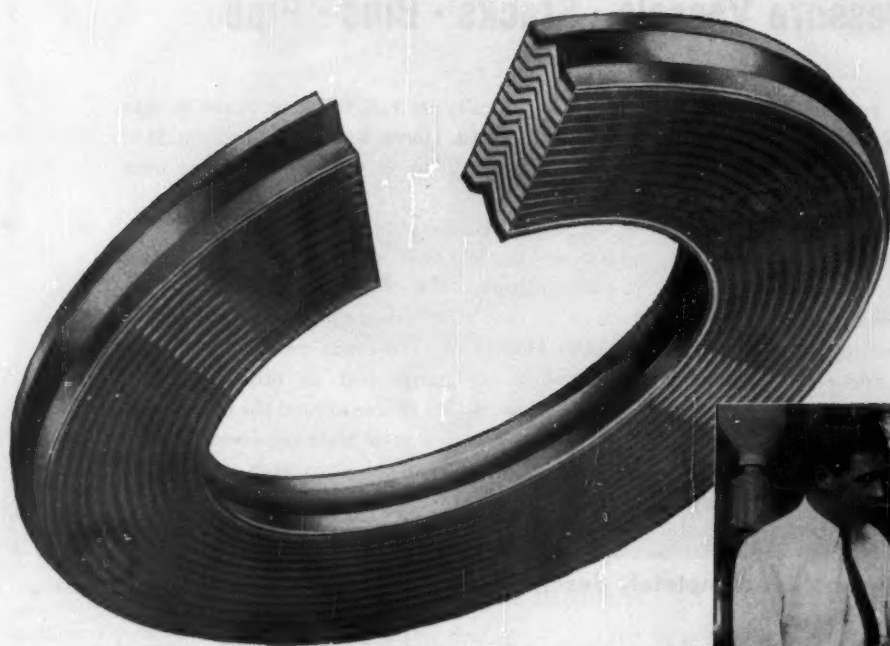


**American Bridge
Division of**



United States Steel

Why **CHEMICAL ENGINEERS** with these



Automatic spring action of V-shaped metal plies react to variations in compression, internal pressures, and temperature changes. Assure leak-proof seal under most severe conditions.



GARLOCK GUARDIAN* GASKETS

Provide a safe, positive seal against high temperatures and pressures of steam, oils, gases, liquids.

Construction assures dependable sealing under varying service conditions. Strips of V-shaped stainless steel, alternated with layers of asbestos, are spiral wound to form the gasket. The number of windings are varied to accommodate different established bolt loads.

If you have sealing problems involving temperatures to 1050° F. and pressures to 2500 psi be sure to investigate the advantages of Guardian Gaskets. Available in round, oval, square, flat side, diamond, and pear shapes in practically any size. Write for descriptive folder AD-104.

*Garlock trademark

GARLOCK

*Packings, Gaskets, Oil Seals, Mechanical Seals,
Molded and Extruded Rubber, Plastic Products*

protect equipment **GARLOCK products**



Withstand higher pressures and outlive metal expansion joints . . . do not crack, corrode, lose shape, or require gasketing. Maximum service life at temperatures to 180° and pressures to 125 psi.



GARLOCK RUBBER EXPANSION JOINTS

Prevent flange breakage and equipment breakdowns. Undue stress caused by misalignment, vibration, expansion or contraction of piping or equipment will break connecting flanges. Garlock Rubber Expansion Joints relieve such stresses.

Eliminate vibration and noise. Pumps, compressors, engines, and pressure surges in pipe lines create vibration and objectionable noises. Garlock Rubber Expansion Joints act as an absorbent cushion . . . insulate against transfer of noise to other parts of the building.

These are only two of the many reasons why you should use Rubber Expansion Joints in piping systems for air conditioning, blower lines, brine tanks, jet condensers, pump lines, circulating water lines, etc. Write for Folder AD-137.



THE GARLOCK PACKING COMPANY
Palmyra, N. Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U. S. and Canada.



**Now! Ready-to-install
in a single package—**

- High-temperature insulation
- A protective metal jacket
- A built-in vapor barrier

The insulation in Metal-On is Johns-Manville Thermobestos®... finest of all the calcium silicate insulations for service to 1200°F.

From carton to *... with*

Thermobestos calcium silicate insulation



5 SECONDS TO REMOVE Metal-On from carton. Another 25 seconds to snap on pipe and lock in place!



15 SECONDS LATER the specially designed aluminum "snap strap" (containing vapor seal) has been snapped on joint.



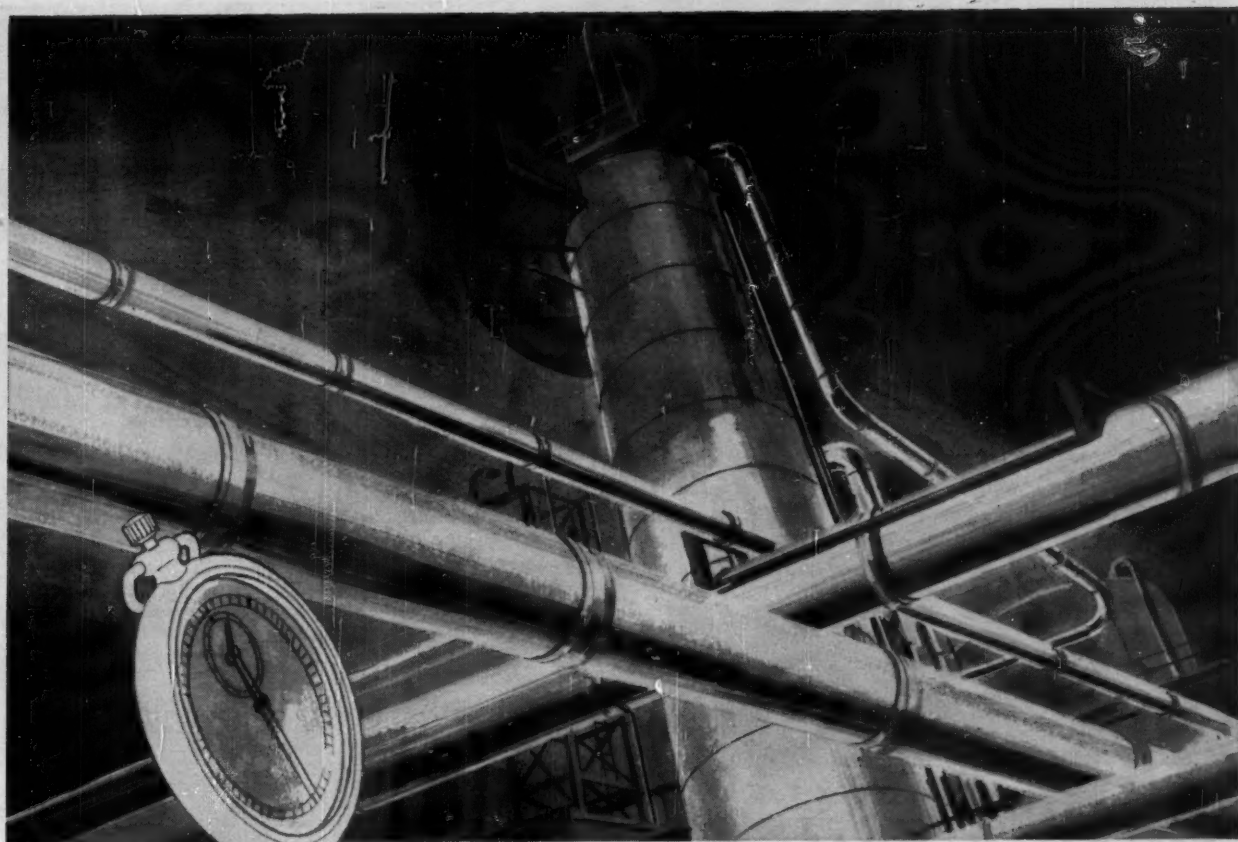
METAL BAND provides perfect joint protection against vapor and weather. Total elapsed time: 90 seconds!

Here's the fastest, most efficient way ever to install high-temperature pipe insulation and protective aluminum jacketing.

Metal-On is the insulation idea all industry has asked for: a single package product that permits application of Thermobestos pipe insulation and corrosion-resistant metal jacket in one fast operation. You'll find that a section of Metal-On can be applied as fast as, oftentimes faster than, an insulation alone.

Snap in place . . . F-A-S-T!

J-M's new Metal-On consists of Thermobestos calcium silicate insu-



Metal-On ends jacket thickness and alloy guesswork! The Metal-On jacket measures an ideal .016-inch thick . . . of a high-quality aluminum alloy selected for superior weather resistance.

pipe in 90 seconds!

new J-M METAL-ON Insulation!

factory-jacketed in gleaming, weatherproof aluminum

lation, a vapor barrier and an all-weather protective covering of aluminum. Furnished ready-to-install, a section of Metal-On snaps on the pipe, locks tightly in place (new locking device is exclusive Metal-On feature) to seal out weather and protect the insulation indefinitely. Joints are sealed tight with aluminum "snap straps" mechanically fastened in place with metal bands.

Right alloy . . . proper thickness

The Metal-On aluminum jacket reduces maintenance in virtually every outdoor pipe application! It never needs painting . . . won't rust . . . is

impervious to surface dirt, oils and grime. The jacketing is made of an aluminum alloy (containing magnesium) that is specially selected for superior corrosion resistance. Jacket thickness is designed to provide, at lowest cost, outstanding appearance, stiffness, workability and resistance to abuse and pitting.

Metal-On presents no fitting problem. It is cut easily right on the job

with either power or hack saws. Available in 36" sections in a complete range of pipe sizes through 24" . . . by 3" thickness.

To help you investigate Metal-On for your next pipe insulation requirement, let us send you the informative brochure, IN-217A. Write for it today. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS...1858-1958





RACKED OR STACKED, during shipment, handling, or storage, Republic Drums provide full-time protection of contents with the strength of steel. In addition, the new low-cost portable drum racks shown are exclusive with Republic. Each will accommodate two loaded 55-gallon drums, permitting stacking to any practical height to save valuable floor space.

*Rack 'em up,
Stack 'em up...*

CONTENTS ARE SAFE

IN REPUBLIC STEEL DRUMS

Wherever you need containers—for handling, shipment, or storage—you can assure full protection of contents by specifying strong, safe, Republic Steel Drums. Available in a wide range of types and sizes, Republic Drums provide a complete service to the chemical industry in both light and heavy gage classifications.

Light Gage Class I. C. C.—17E, 17H, 17C, 6J. Republic offers either tight-end or full-removable-head drums as specified. Drum bodies and heads can be decorated to order. High-bake lacquer linings are available, or drums can be hot dip galvanized or hot dip tinned to handle difficult-to-hold materials.

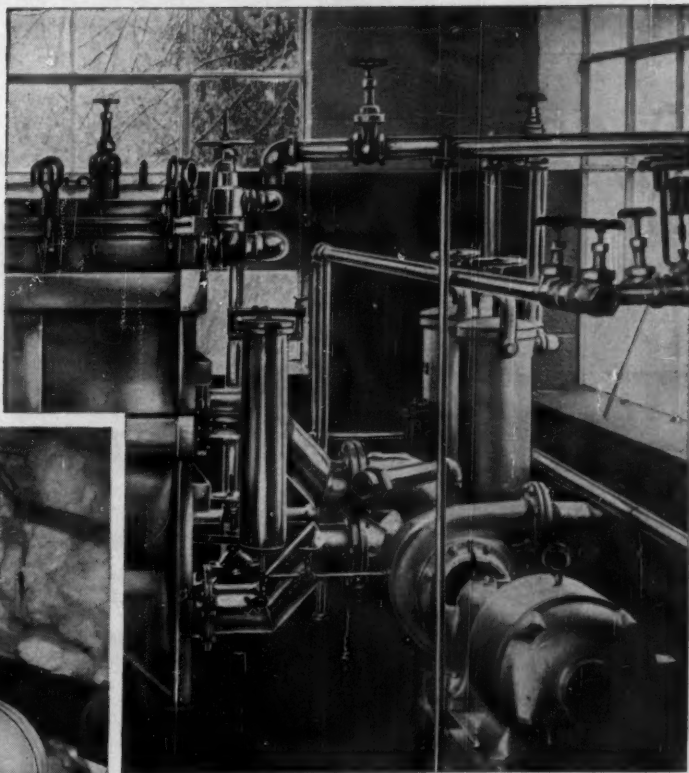
Heavy Gage Class I. C. C.—5, 5A, 5B, 5C, 17F and certain I. C. C.—6 Series. Drums are available in 55-, 30-, and

20-gallon capacities, from 16- to 12-gage in hot rolled carbon steel, depending on specification and service. As with the light gage service, hot dip galvanizing and hot dip tinning can be provided. In addition, Republic offers containers made of ENDURO® Stainless Steel for the ultimate in long-lasting, trouble-free, corrosion-resistant performance.

Republic also produces a full line of Steel Packages from 3½- to 20-gallon capacities. Gages range from 26 to 20 in plain steel. Decoration and special high bake linings can be applied to meet individual requirements.

It will pay you to assure full protection for your materials with Republic Steel Drums. For detailed literature, send coupon.

SAFE HANDLING OF NUMEROUS CHEMICAL FLUIDS is no problem when you install Republic **ELECTRUNITE®** ENDURO Stainless Steel Pipe and Tubing. In this mill, **ELECTRUNITE** Pipe carries dye solutions without danger of contamination or loss. This strong, quality pipe offers great resistance to heat, rust, and corrosion—is a dollar-wise investment in long-range economy. Send coupon for facts.



REPUBLIC SRK PLASTIC PIPE has proved ideal for use with many chemically active agents. **SRK** (Semi-Rigid Kralastic) is inexpensive, light in weight, and exceptionally strong. It's easy to install, even in cramped quarters. Can be cut with ordinary hand saw. Joints are made with brush-applied solvent and socket-type fittings—or threaded male and female adapters can be furnished for conventional joining. For details, mail coupon.

REPUBLIC STEEL



*World's Widest Range
of Standard Steels and
Steel Products*

REPUBLIC STEEL CORPORATION

DEPT. CE-5501-R

1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send me more information on:

- ☐ Steel Drums and Packages ☐ Portable Drum Racks
☐ **ELECTRUNITE** ENDURO Stainless Steel Pipe and Tubing
☐ **SRK** Plastic Pipe

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

A complete, integrated service
IN LIQUID-SOLIDS SEPARATION

Tolhurst[®] CENTRIFUGALS



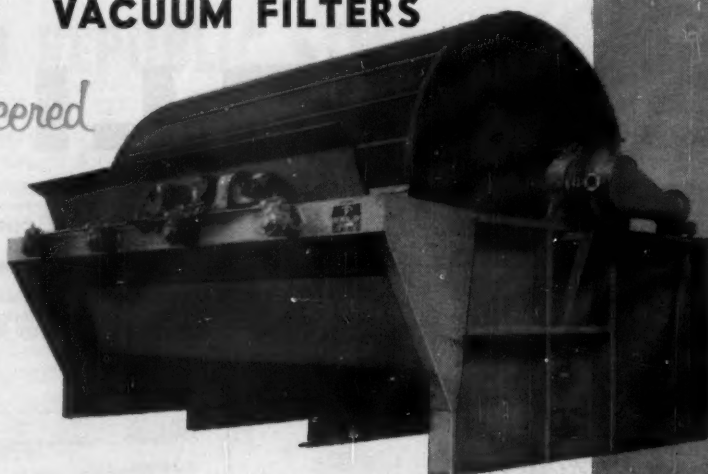
- * BATCH-O-MATIC[®]
- * BATCH-MASTER[®]
- * SUSPENDED
- * CENTER-SLUNG[®]
- * MAXI-FLEX[®]
- * CONTINUOUS

FE INC[®] VACUUM FILTERS

Custom Engineered

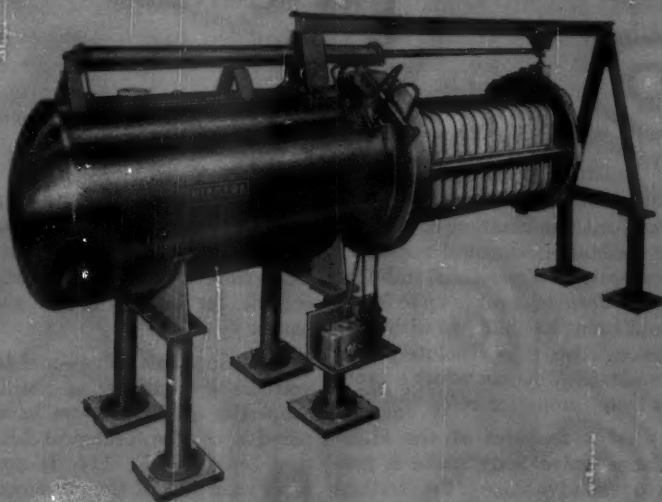
- * DISCHARGE
*string
scraper
roller*

- * FILTERS
*precoat
horizontal*



now offered by *Specialists*

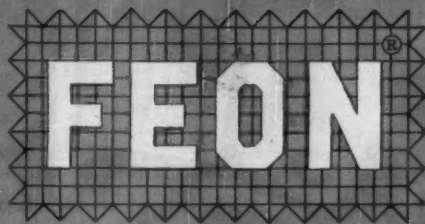
Niagara[®] FILTERS



* **VERTICAL LEAF MODELS** in both horizontal and vertical tank designs.

* **BATCH-MISER[®]** horizontal plate models for polish filtration and batch operations.

* **ALL ASME Code Construction.**



* **SYNTHETIC FILTER FABRICS**

Available as yard goods or tailored to fit all types of pressure and vacuum filters, centrifuges, dust collectors and other industrial process equipment.

DIVISIONS OF
American Machine and Metals, Inc.
EAST MOLINE, ILLINOIS

COMPLETE LABORATORY TESTING FACILITIES AT YOUR SERVICE

Now Penton's* Miracle Characteristics are put to use in Diaphragm Valves!

Hills-McCanna's Exclusive New Lining Meets Many of the Service Requirements That Once Called For Stainless Steel and Glass!

By: R. McFarland,
Technical Director,
Hills-McCanna Company

Here at Hills-McCanna an exhaustive search has paid off: a new lining material for diaphragm valves matches the economies of rubber lining while meeting many of the service requirements of glass lining and stainless steel.

A new Penton plastic-lined valve body (pictured below) has been developed, tested and readied for the specialized needs of the processing industries.



A six inch and three quarter inch Penton lined valve body

Because of its wide versatility, we believe a brief rundown on the new product's unusual characteristics and its ability to cope with diverse chemical service applications will be of interest to you.

Economically, the Penton plastic-lined valve stands alone. Competitively priced with rubber-lined valves, it meets every requirement placed on the hard rubber-lined types. This versatile valve has the ability to meet many of the service requirements that once called for the higher-priced stainless steel and glass-lined valves.

Performance-wise, Penton (a chlorinated polyether polymer), a product

of Hercules Powder Company, affords an excellent combination of temperature resistance, chemical resistance and exceptional dimensional stability. *Penton is durable*: it takes up to 300°F without losing its ability to withstand corrosion. Also, it is absolutely non-contaminating; cannot affect a product's taste, aroma or color.

The design features of the Hills-McCanna valve body make it possible to take advantage of the excellent properties of the Penton lining. Chemically resistant Penton lining, in an armored body of cast iron or aluminum, offers the most universally adaptable processing valve available today. It handles *more* substances . . . and works equally well with metallic, plastic, glass and lined piping.



Above is a complete handwheel operated Diaphragm Valve with Penton lined body
Penton lined diaphragm valves are available in sizes $\frac{1}{2}$ " thru 6" with flanged ends, and diaphragm valves with solid Penton bodies are available in sizes $\frac{1}{2}$ " thru 2" with screwed ends.

As with all Hills-McCanna diaphragm valves, the valve is of packless construction. Its working parts are isolated from flow, and are easily accessible for simple in-line maintenance.

To introduce this valve—and to give you the opportunity of noting the properties of Penton—we have prepared a concise Technical Information Bulletin, No. 114. It contains more than 250 of the more common chemical services, temperature and pressure specifications, and elaborates on the typical services in which Penton lined valves can be used.



Supplementing the booklet is the Penton "Dollar." An immersion disc of solid Penton, it can be used to demonstrate its unusual chemical and temperature resistance characteristics. Let the Penton "Dollar" show you how you can save dollars with the use of Hills-McCanna Penton lined valves in your plant. Both Bulletin and "Dollar" are available via letterhead request. Write: *Hills-McCanna Company, 4568 W. Touhy Avenue, Chicago 46, Illinois.*

*Penton is a registered trade name of Hercules Powder Company

FOR CORROSION RESISTANCE AT ELEVATED TEMPERATURES

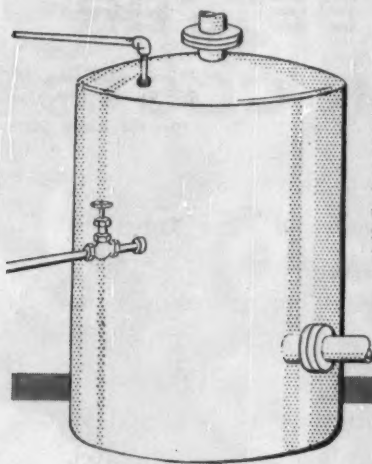
check the Penton^{*} package

A completely new thermoplastic with a broad spectrum of corrosion resistance, Penton may well supply the answer to some of your toughest corrosion problems—particularly at elevated temperatures.

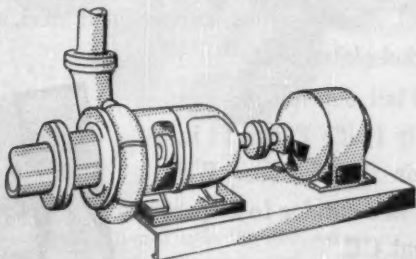
The unique combination of mechanical and chemical-resistant properties found in Penton, combined with the ease and economy with which it can be fabricated, makes this new material ideal for the production of anti-corrosive equipment in many forms. Although new as a commercial product, Penton has been thoroughly evaluated and its usefulness proven in many tough corrosive exposures even at temperatures exceeding 300°F.

Check the advantages of the proved-in-use Penton package for complete processing systems. Valves, pipe and fittings, pumps and meters, flame-sprayed or whirl-sintered metal parts—all are now available for immediate use offering the extra protection of Penton. We'll be glad to put process equipment users in touch with a manufacturer who now offers Penton products.

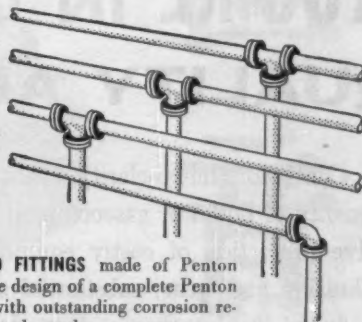
Whether you are a user or manufacturer of processing equipment you'll want to know more about Penton. Write for a copy of "The ABC's of Penton for Corrosion Resistance" or the technical brochure designed for equipment manufacturers.



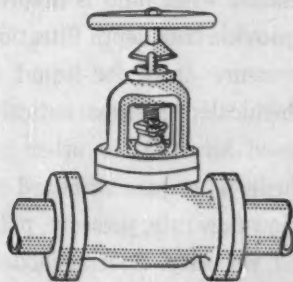
PENTON COATINGS AND LININGS applied by flame-spray or whirl-sintering convert ordinary metal tanks into highly corrosion-resistant vessels.



PUMP AND METER PARTS molded with Penton or made with Penton-clad metal extend the usefulness of this new plastic in processing systems.



PIPE AND FITTINGS made of Penton enable the design of a complete Penton package with outstanding corrosion resistance at elevated temperatures.



PENTON VALVES of many types, solid or lined, can now be obtained in sizes up to 6 in., meet many service needs previously requiring higher-priced glass or metal alloy parts.

Cellulose Products Department

HERCULES POWDER COMPANY

INCORPORATED

900 Market Street, Wilmington 99, Delaware

^{*}Hercules Registered Trademark for Chlorinated Polyether

CHEMICAL ENGINEERING—September 8, 1958

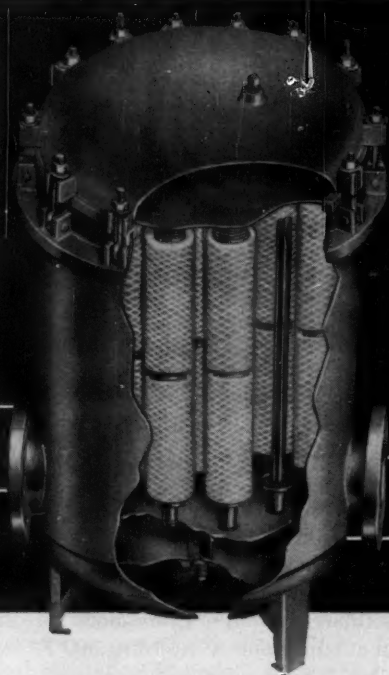


CP58-6

with

Fulflo
FILTERS
REG. U.S. PAT. OFF.

IN YOUR PROCESS LINE



YOU'RE IN LINE FOR BETTER QUALITY AND LOWER COSTS

Continuous micro-clarity means improved quality of liquid or gaseous products; positive protection of costly equipment from abrasion and wear; substantial savings in reduced maintenance, less down-time, increased production.

No matter what fluid is involved, Fulflo Filters provide true depth filtration at minimum pressure drop: for liquid chemicals; petro-chemicals; pharmaceuticals; water; compressed air; CO₂ or other gases; oils; liquid fuels. There are standard models for high or low flow rate, pressure, pH, temperature and viscosity. Special models may be engineered for full-flow filtration up to 2000

gpm or pressures as high as 5000 psi.

Exclusive Honeycomb Filter Tubes are made in a wide range of positively controlled densities to give you any desired degree of micro-clarity.

You have a broad selection of elements — cotton, nylon, orlon, dacron, dynel, acetate, or glass fibres; containers of iron-and-steel, steel, stainless steel, rubber-lined steel, and nickel-plated brass.

Find out how economically Fulflo Filters fit into your installations. Write for new catalog to Department CE.



COMMERCIAL FILTERS CORPORATION

MELROSE 70, MASSACHUSETTS

PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

MICRO-CLARITY AT MINIMUM COST



with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.



Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.

CHLORINE

the green goddess



觀
世
音

To the Buddhist, Kuan Yin is the goddess of mercy. To the chemist, this green goddess symbolizes chlorine — one of the most widely useful of all elements. Purifier, oxidant, bleach, extracting agent, its uses range from papermaking to ore reduction, from food-stuffs to insecticides, through scores of chemical and industrial processes. Its source, to many users throughout Mid-America, is Frontier Chemical Company . . . where salt brine is electrolyzed to produce chlorine

that consistently exceeds 99.9% purity. From Wichita, Kansas, Frontier offers fast shipments by rail in 16, 30 and 55-ton tank cars and multi-unit cars of one-ton containers. From both Wichita and Denver City, Texas, Frontier also delivers by truck in one-ton containers. Frontier chlorine is tailored to your specifications for: Purity • Dryness • Accurate weight loading • Unloading convenience • Prompt shipment • Controlled quality. We are at your service.

Frontier CHEMICAL COMPANY

BASIC PRODUCERS OF CHEMICALS FOR MID-AMERICA

FOR COMPLETE LIST SEE OTHER SIDE →

FRONTIER

*Mid-America's
Basic Producer of*

Caustic Soda

Muriatic Acid

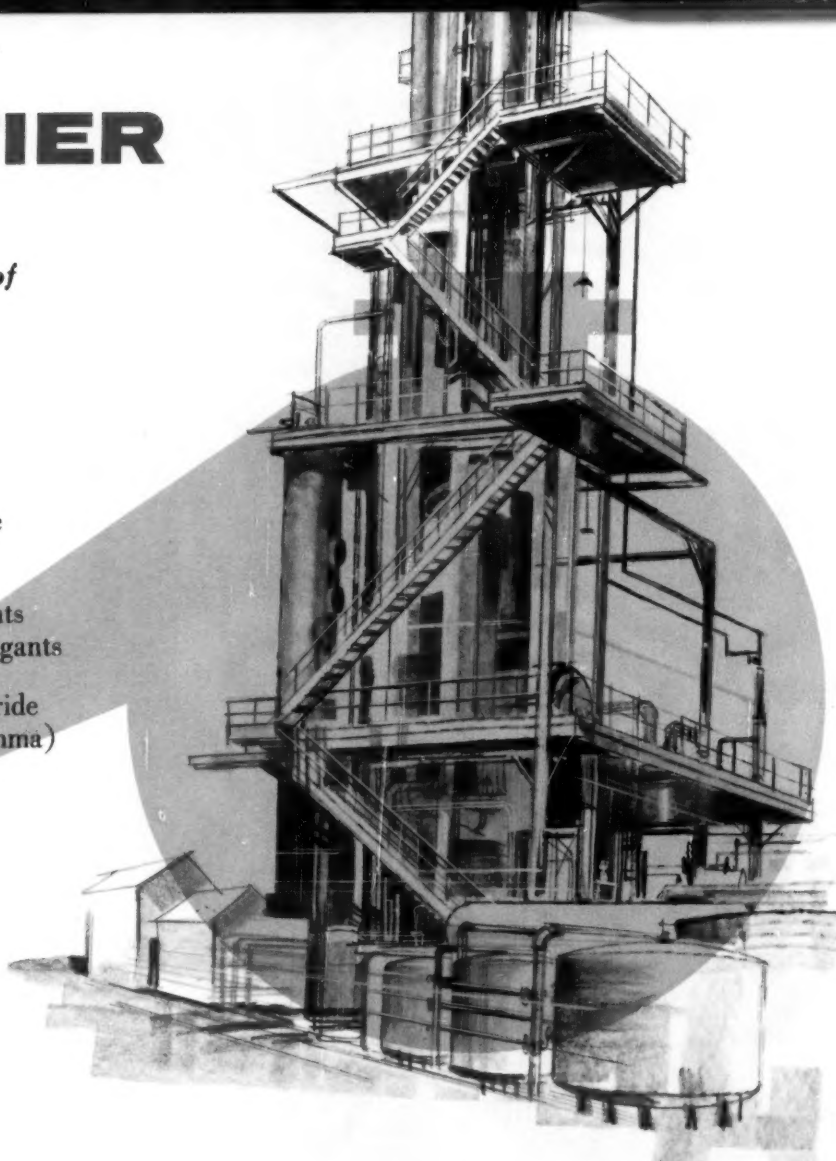
Chlorine

Hydrogen Chloride
(Anhydrous)

Chlorinated Solvents
and Grain Fumigants

Benzene Hexachloride
(14 and 36 gamma)

Fine Grain Salt



Perhaps you can profit from Frontier's strategic Mid-America locations — so much closer in time and distance to many users. You are sure to gain in other ways. You benefit from rigid quality control — the result of production from Frontier-controlled basic materials in one of the industry's newest and most advanced plants, and contamination-free shipment in Frontier's own new tank cars, highway tank-trailers, or standard containers. You can build mixed lot shipments from Frontier's wide and growing line of products. Or you can locate your own new plant next door to ours, for easy "over-the-fence" deliveries. You'll like Frontier's sincere personal interest in your needs — our prompt and friendly service. We will appreciate your inquiry.



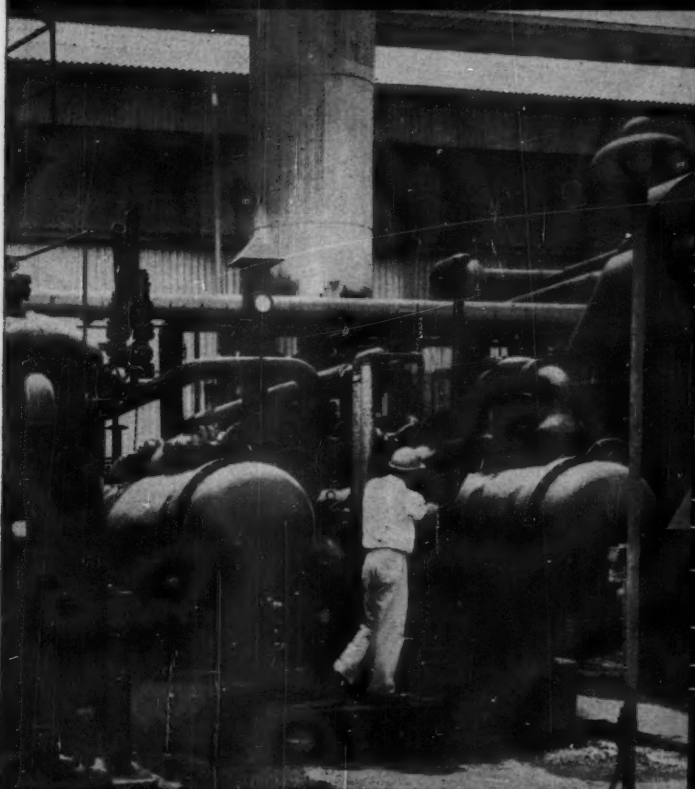
Frontier[®] CHEMICAL COMPANY
DIVISION OF VULCAN MATERIALS COMPANY
EXECUTIVE OFFICES: MUNICIPAL AIRPORT, WICHITA, KANSAS



"Organized for Service"

THIS IS VULCAN MATERIALS COMPANY:
Birmingham Slag Division, Brooks Sand & Gravel Division, Chattanooga Rock Products Division, Concrete Pipe Division, Consumers Division, Lambert Division, Montgomery-Roquemore Gravel Division, Stockbridge Stone Company, Vulcan Detinning Division, Frontier Chemical Company, Teckote Corporation, Wesco Contracting Company.

At Spencer Chemical Company Ammonia Plant...
LECTRODRYERS stretch periods between defrostings



**BY DRYING
SATURATED AIR**

*—1 million cubic feet
per hour at 600 psi
and 40° F to minus
60° F dewpoint*

**BY DRYING
SATURATED HYDROGEN**

*—20 million cubic feet
per day at 300 psi
and 40° F to minus
80° F dewpoint*

At Spencer Chemical Company's Vicksburg, Mississippi plant, ammonia is produced by a process employing partial oxidation of natural gas. The other raw material is air... about 1,000 tons per day are liquified in an air-separation plant.

Lectrodryers stretch periods between defrosting... cut processing slowdowns and extend heat exchanger life. They DRY a million feet of saturated air per hour to a minus 60° F dewpoint... 20 million cubic feet of saturated hydrogen per day to a minus 80° F dewpoint.

Removing unwanted moisture with Lectrodryers can create new high levels of efficiency in any

process involving air, gases or organic liquids. Lectrodryer engineers—utilizing more than 25 years of specialized experience—can fully appraise your moisture-removing requirements and recommend the best type of dryer for each application.

**DO YOU HAVE A MOISTURE PROBLEM
IN PROCESSING OR STORAGE?**

Write for LECTRODRYER questionnaire, on which you can provide us with information needed to make specific recommendations regarding your drying needs. Pittsburgh Lectrodryer Division, McGraw-Edison Company, 303 32nd Street, Pittsburgh 30, Pennsylvania.

Leading industries look to

Lectrodryer[®] 

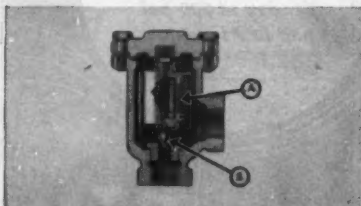
World's First and Foremost Manufacturer of Commercial and Industrial Adsorbent Dryers

Full-range steam traps cut high cost of steam pressure variations

By John W. Ritter, Test Engineer
SARCO Company, Inc.

While boiler room economics dictate that boiler pressures remain constant, the equally sound economics of batch processing may decree that pressures at the equipment vary with the requirement of the process. The attempt to choose a steam trap that is all things to all conditions may result in installing traps that operate inefficiently at either extreme of their pressure range or that require adjustment every time the operations sheet calls for another pressure-temperature setting. Orifice traps represent a somewhat more rational approach to the problem, but often at the price of a continuous discharge of steam, particularly at the low pressures of start-up and shut down. Compromise, adjustment, and steam waste all spell inefficiency in the utilization of steam.

Production-Planned steam trapping, on the other hand, improves efficiency by the use of properly designed and installed thermostatic steam traps. Such traps employ the expansion and contraction of a thermostatic element to operate the discharge valve.

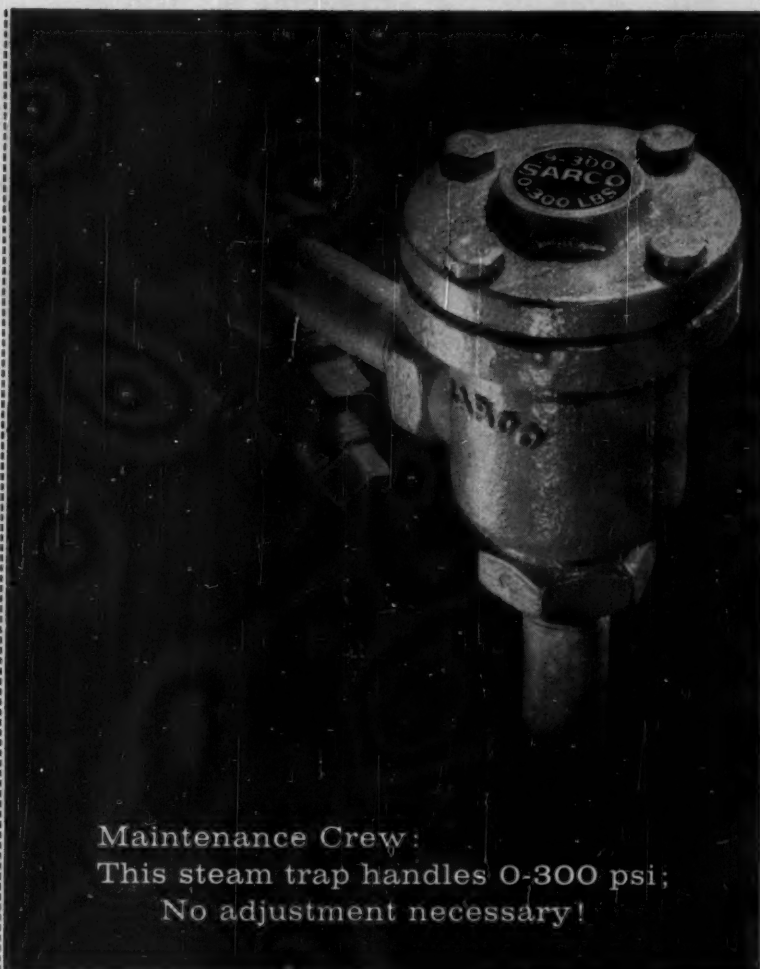


In Sarco Thermostatic Steam Trap, element (A) expands at steam temperature to close valve (B), contracts to permit discharge of condensate.

In the Sarco "Balanced Pressure" Thermostatic Steam Trap a volatile fluid is sealed inside a metal bellows that opens or closes the valve as it contracts or expands with condensate temperature. Near steam temperature, evaporation of the fluid creates an internal pressure greater than steam pressure in the trap body, and the expanding bellows seats the valve. When the condensate cools, the element contracts and opens the valve.

It is evident that at steam temperature pressure inside the element is higher than steam pressure, no matter how the latter may vary. Thus, the trap compensates automatically for variations in pressure.

58108



Maintenance Crew:
This steam trap handles 0-300 psi;
No adjustment necessary!

Sarco "Balanced Pressure" Thermostatic Steam Traps cut trap maintenance costs and simplify parts inventory. Why? Because the same bellows, head and seat handle steam pressures up to 300 psi — without any need of adjustment for variations in load or pressure.

Other advantages: unmatched capacity/cost ratio (1" size discharges 9,650 lbs/hr. at 10°F below steam temperature, 125 psi). This trap can't air-bind and, when installed with free discharge, can't freeze.

Long life and reliable performance are assured by an exclusive Sarco process for fabricating the one moving part — the thermostat — and by steam-testing of every single trap at maximum rated pressure.

Write for "Literature Kit 1A" today. And remember, Sarco can give you impartial advice on *Production-Planned* steam trapping because...

SARCO
COMPANY, INC.

635 Madison Ave., New York 22, N. Y.

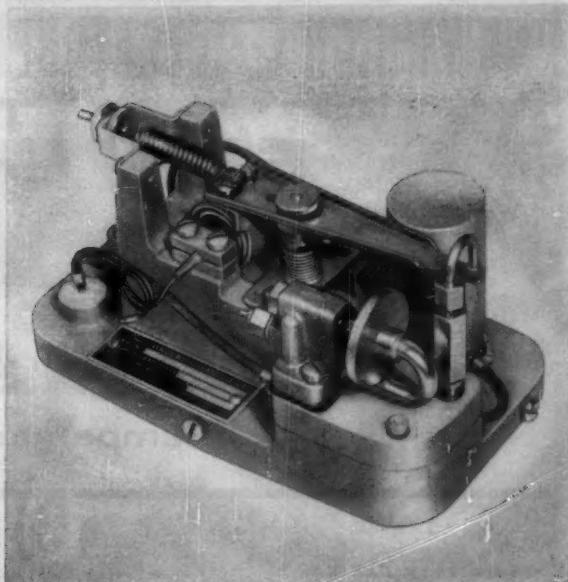
Only Sarco makes all 5 types:

Thermostatic • Liquid Expansion • Float Thermostatic
Thermo-Dynamic • Bucket

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES



LOW COST AND EASE OF INSTALLATION PERMIT WIDE USAGE.



OPERATIONAL SIMPLICITY IN A RUGGED, COMPACT UNIT.

TAYLOR ANNOUNCES NEW LOW-COST TEMPERATURE TRANSMISSION

**New SENSIRE* Transmitter: rugged, compact,
force-balance, with mercury-filled system.
Self-compensating for ambient temperatures.**

The new Taylor SENSIRE temperature transmitter now makes more widely available low cost temperature measurement within limits of minus 30°F. to plus 1200°F., with simplified adjustments and excellent repeatability.

Individual transmitters are factory calibrated in one of four available range spans. A simple thumb-screw adjustment zero-sets the instrument within wide limits. This adjustment is accomplished with high accuracy, and no further calibration is necessary. Factory calibrated accuracy is well within 1% of rated range, below 550°F; 1½ % above 550°F.

All SENSIRE transmitters and components are interchangeable (regardless of range). A measuring system encompassing a new range span or new range limits (other than those obtainable with zero adjustment) may be added in the field.

Write for SENSIRE **Bulletin 98293**, or see your Taylor Field Engineer, Taylor Instrument Companies, Rochester 1, N.Y., or Toronto, Ontario.

*Trade-Mark

Taylor Instruments
MEAN ACCURACY FIRST

CHEMICAL ENGINEERING—September 8, 1958



Unusually Fast Response. Due in part to its extremely small bulb, the SENSIRE transmitter has an unusually fast speed of response. However, for processes that require it, the SPEED-ACT* (derivative response adjustment) unit is available. The SPEED-ACT feature is of special value where the bulb is placed in a well, or in processes using material with poor thermal transmission rates.

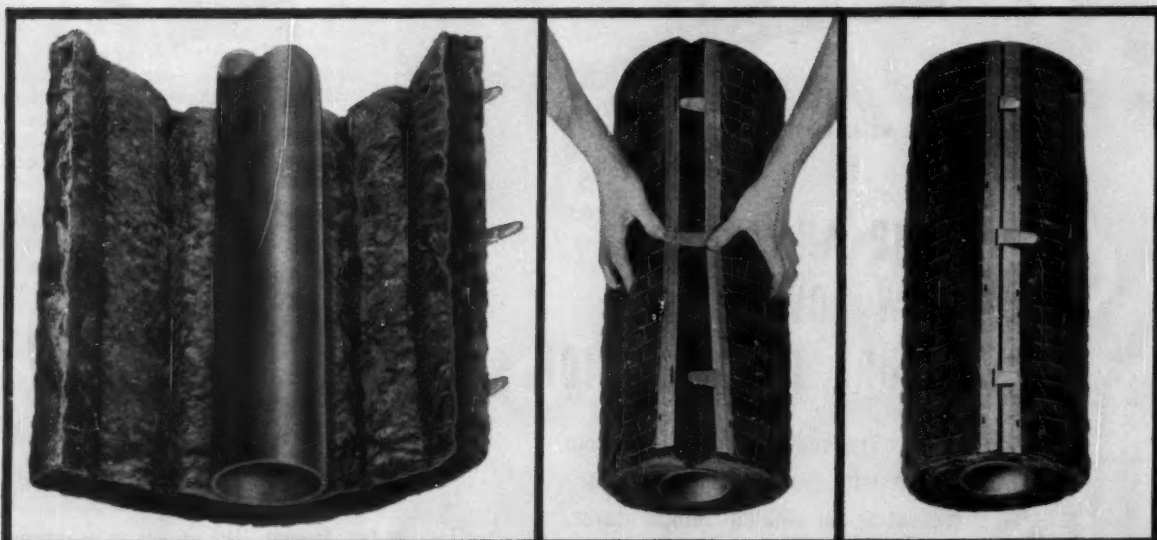


Easy to Install. Mounts in any position. Universal bracket provides for direct mounting on pipe, wall, or wrench head of well or separable bushing. Small and extremely compact, the SENSIRE transmitter measures only 7¼" x 4¾" x 4½"; weighs only 7 lbs.

NOW! HIGH TEMPERATURE INSULATION - EASY TO APPLY

EAGLE-PICHER TAB-LOK PIPE INSULATION

For temperatures up to 1200F



And it's made of Eagle-Picher Mineral Wool!

SAVES TIME AND LABOR! On long overhead steam transmission and steam tracer lines, apply *Tab-Lok* in about half the time required by ordinary pipe coverings. Easy to handle... cut and fit... simply draw tabs through slots, pull taut and bend tabs over. No reinforcing needed!

PRECISION-MADE TAB-LOK is Eagle-Picher's new, highly efficient mineral wool pipe insulation, especially designed for fast, easy application on steam piping and hot lines up to 1200 F.

TIGHT, UNIFORM INSULATION! Durable metal fabric and galvanized strips keep *Tab-Lok* in uniform alignment. The unique tab-and-slot feature assures tight, close-butted joints.

WHAT'S MORE... Eagle-Picher's new *Tab-Lok* pipe insulation is highly resilient for minimum stress in expansion and contraction of heated equipment. It's water-repellent, corrosion-resistant, fire-resistant, vibration-resistant! Its greater efficiency plus ease and speed of application, saves you money!

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.

Since 1843



EAGLE-PICHER

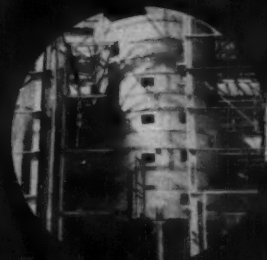
The Eagle-Picher Company • General Offices: Cincinnati 1, Ohio

(Member of Industrial Mineral Fiber Institute)

Engineered Heat...



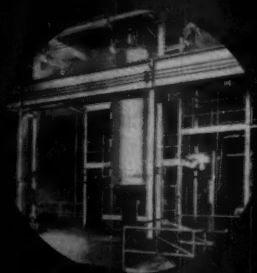
ROASTING



CALCINING



DRYING



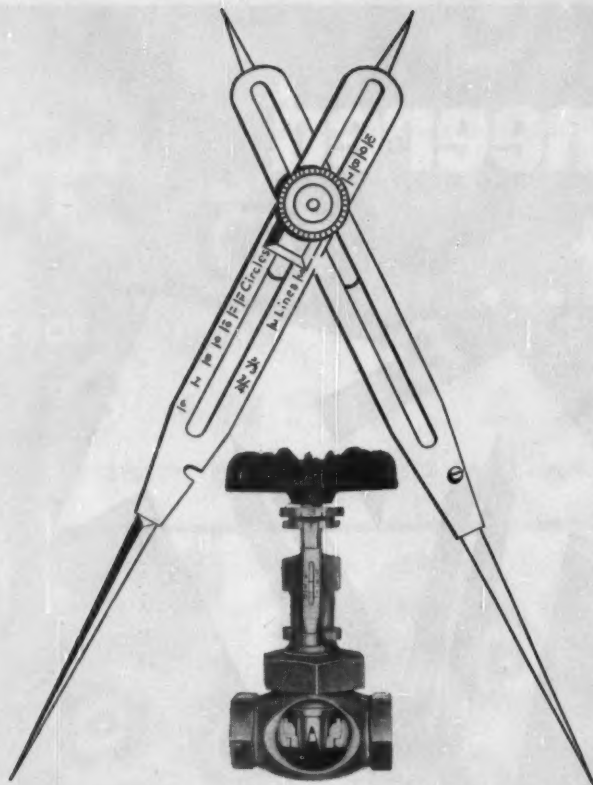
REGENERATION

.. FOR PROCESSING CHEMICALS-MINERALS

Nichols furnace equipment for thermal processing of all types of chemicals and minerals ranges from laboratory size 10 lb. batch units to 10,000 ton per day plants. Nichols services provide Research, Design and Construction.

Write for Bulletin No. 233

NICHOLS Engineering & Research Corp.
70 PINE ST., NEW YORK 5, N. Y.
3513 N. Hovey St., Indianapolis 18, Ind.
405 Montgomery St., San Francisco 4, Calif.
1477 Sherbrooke St. W., Montreal 25, Canada



PROPORTIONER

controls flow to save for you

The V-port disc in all Hancock "Flocontrol" Valves insures proportional flow throughout the entire lift of the stem. They are valves that help you achieve uniform product quality through closer control, save steam and fuel on process work, and cut maintenance costs.

"3 in 1" valve design combines variable orifice with shut-off and micrometer dial and pointer. The valve opening can be set within 1/10 turn of the handwheel—you can duplicate all settings easily, instantly. No shut-off valve required—flow is in a straight line, with separate shut-off seating surface located away from the V-ports.

Hancock "Flocontrol" Valves are available in Bronze and Steel to meet the most demanding services. Ask your industrial supply distributor for details.



Hancock "Flocontrol" valves assure positive pinpoint control—eliminate all guesswork.



HANCOCK "FLOCONTROL" VALVES

A product of

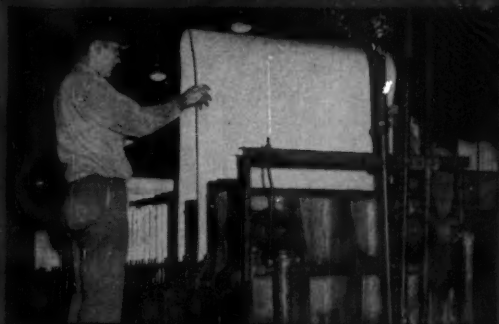
MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

CHEMICAL FIBER

WINDSOR FELTS



... a *proven* new class of FILTER MEDIA!

Fiber-welded Fabrics Offer High Efficiency Particle Retention

Economical Windsor Felts eliminate the use of secondary dressing materials in many filtering applications!

They're fabricated from selected synthetic fibers to meet your individual specifications...and feature a *unique*, engineered construction with precision controlled pore size which provides the following significant advantages:

- Rapid filter cake build-up
- Minimum recycle time
- High flow rate
- Dimensional stability
- Ravel free, clean cut edges
- Positive gasketing—minimum leakage
- Easy cake release
- Greater product recovery
- Lower cost

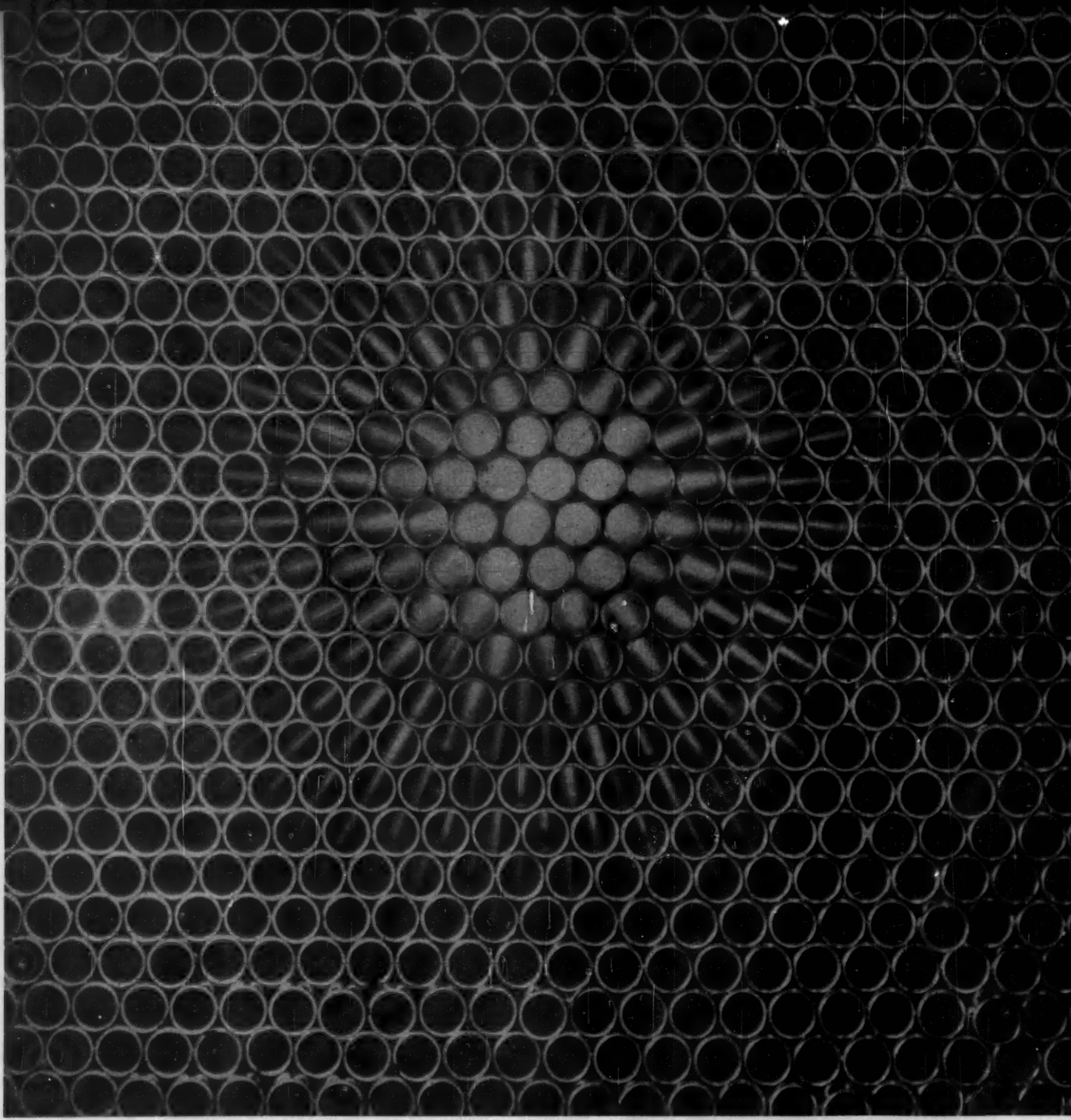
Windsor Felts are *now* in use on all types of filtration equipment...inquire how they can improve *your* operations, write for Data Sheet #18, on company letterhead, please.

Remember: American Felt Company has the most extensive and best equipped staff of product engineers in the Felt industry with *engineered* materials for seals, wicks, decoration, vibration mounts and polishing...for information, write to...

General Offices
and Engineering
And Research
Laboratories
317 Glenville Road,
Glenville, Conn.

American Felt
Company



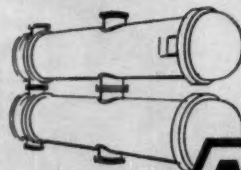


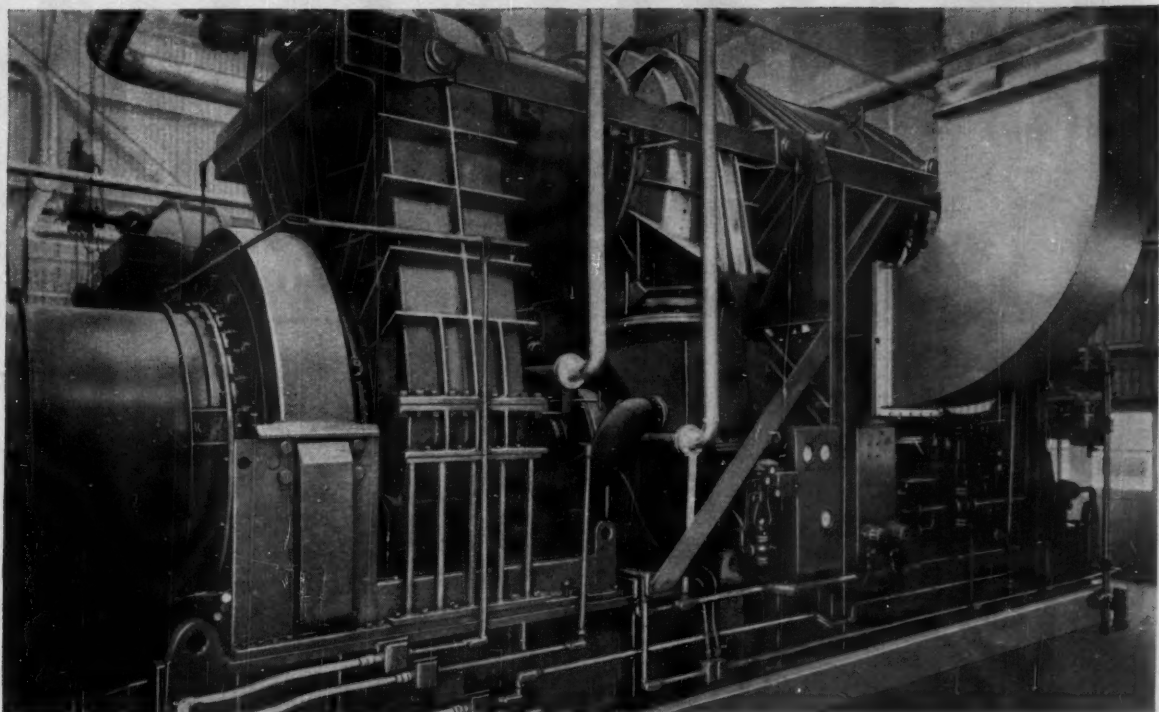
READY TO BUNDLE into heat exchangers for chemical and petroleum service, tubes and other standard components are kept fully stocked for assembly-line production at Kellogg's fabricating shops in Jersey City. Whatever your requirements, Kellogg assures strict conformance to the highest engineering and fabricating standards. For prompt deliveries plus engineering excellence at optimum cost, call Kellogg's Fabricated Products Division.

THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17, N.Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

*The Canadian Kellogg Company Limited, Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas*





In BUTADIENE APPLICATION Clark Gas Turbines supply regeneration air

Odessa Butadiene Company's new plant at Odessa, Texas, integrates two Clark Model 305 gas turbines in the butadiene process by using them to furnish regeneration air to the dehydrogenation unit. These turbines operate in parallel, along with a Clark 3900 HP centrifugal compressor, and discharge air at 950°F and 22 PSIA into a direct fired heater, then to the reactor catalyst beds where the air removes carbon and replaces heat lost in the endothermic dehydrogenation reaction. This regeneration air is then directed to two waste heat boilers where it generates 186,000 pounds per hour of 250 psi steam.

Clark gas turbines were selected for this application because of better over-all plant economics which resulted from savings in fuel coupled with lower maintenance and operating costs. This plant is an

operating testimonial of the dependability and versatility of the Model 305 gas turbine. The power turbine has been removed to allow the hot pressurized gases to be exhausted to the process, rather than convert the energy of the gases to mechanical power as is normally done.

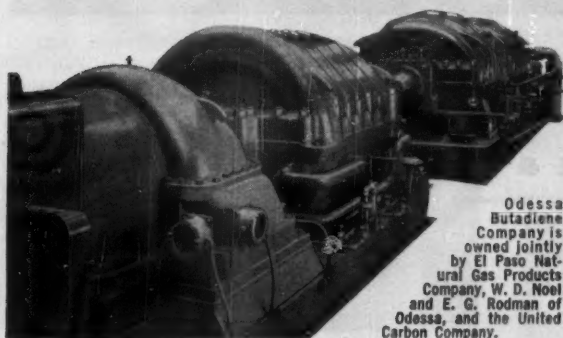
Other services in which Clark gas turbines are in continuous operation are: catalytic reforming, ethylene production, and power generation. In the very near future, additional units will be used in repurifying projects in the Near East and Venezuela.

Clark gas turbines are available in sizes of 1150 to 9300 HP, and are precision engineered and built for the ultimate in dependable and economical heavy duty service. For complete information on Clark gas turbines, contact your nearby Clark representative, or write today for Bulletin 163-1 to Clark Bros. Co., 1815 Lincoln Avenue, Olean, New York.

CLARK BROS. CO.

One of the Dresser Industries

Sales and service outlets in principal cities throughout the world



Odessa Butadiene Company is owned jointly by El Paso Natural Gas Products Company, W. D. Noel and E. G. Rodman of Odessa, and the United Carbon Company.



COMPRESSORS • GAS TURBINES

ALUMINUM GATE VALVES

BY DARLING

FEATURING:

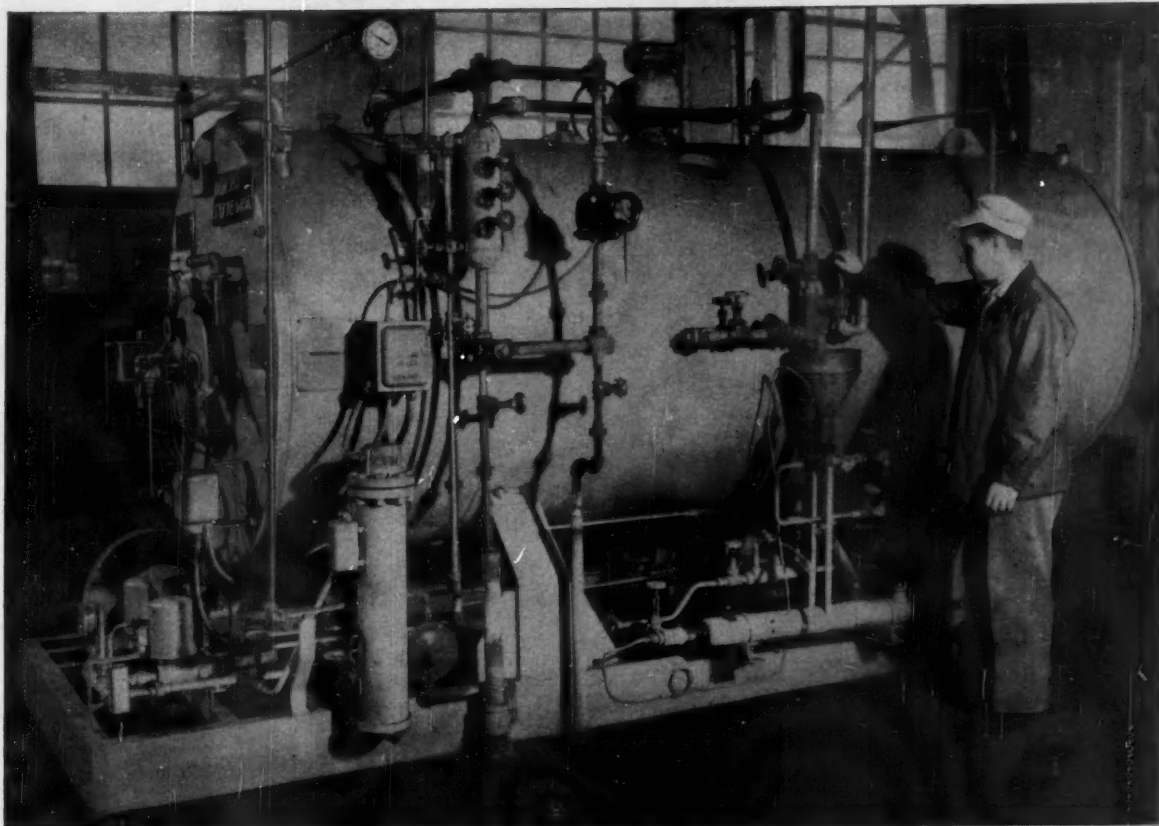
**unmatched advantages
of DARLING fully revolving
double disc parallel seat
gate valve principle!**

There's new economy to be gained in the handling of "problem" fluids and gases with Darling aluminum alloy gate valves... now available in 1/2" through 24" sizes. We have data on initial and long-range costs and performance that will interest you. Write for facts.



DARLING VALVE & MANUFACTURING CO.

Williamsport 3, Pa.



125 HP AMESTEAM GENERATOR Installation at Delaware and Hudson RR Diesel Shops at Binghamton, N. Y.

D & H R R ESTIMATES **\$30,000** ANNUAL SAVINGS WITH FOUR **AMESTEAM** AUTOMATIC BOILERS GENERATOR

"... we estimate \$10,500 annual savings ... more than 44 percent return on our investment ... with the 125 HP AMESTEAM GENERATOR installation at our Binghamton diesel shops alone ..."

And that's only *one* of four AMESTEAM GENERATOR installations mentioned in a letter to us from Mr. P. O. Ferris, Chief Engineer of the Delaware and Hudson Railroad. Mr. Ferris goes on to say ...

"At the present time we have installed these generators at the following locations, at the estimated total annual savings of \$29,899 shown:

LOCATION	H. P.	Estimated Annual Savings	Percent Return On Investment
Rouses Point	125	\$ 8,350.00	33.2
Whitehall	200	6,841.00	22.3
Mechanicville	80	4,208.00	19.7
Binghamton	125	10,500.00	44.2
ESTIMATED TOTAL ANNUAL SAVINGS		\$29,899.00	

What more can we add to this factual testimonial of satisfaction from the Delaware and Hudson Railroad? Only this: we have on file similar reports from hundreds of satisfied users of AMESTEAM GENERATORS. Among leading railroads

alone, we number 40 satisfied customers ... using 194 of our economical, dependable "package type" boilers.

This all adds up to *your* assurance of savings and satisfaction with AMESTEAM GENERATORS.

AMES IRON WORKS INC.

BOX 5-98

OSWEGO, N. Y.

WHAT'S YOUR STEAM PROBLEM ?

For high-quality automatic package boilers, 10 to 600 HP, write us today for the name of your AMESTEAM GENERATOR Representative and our latest catalog.

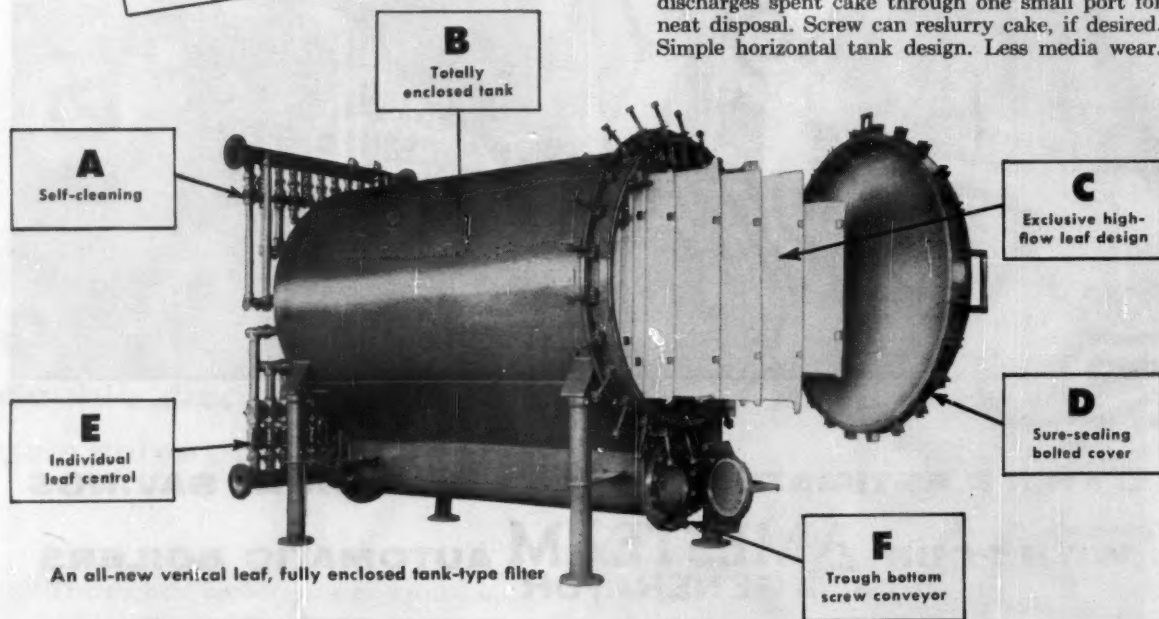
SPARKLER *Presents* NEW VERTICAL PLATE FILTER... MODEL RSC

EXCLUSIVE OPERATING ADVANTAGES

Greater Clarity Control—Sight glasses, sample cocks and individual control valves for each leaf provide continuous clarity control. Should any leaf not function properly, it may be shut off without interrupting operation.

Minimum Manpower Required—A single non-skilled individual is capable of operating a large battery of RSC filters including filter aid addition, cleaning, precoating and supervising.

Faster Cleaning, Easier Maintenance—A 560 sq. ft. Model RSC can be cleaned in 10-15 minutes (30-45 minutes total down-time). Leaves are sprayed clean individually. Screw conveyor in trough bottom discharges spent cake through one small port for neat disposal. Screw can reslurry cake, if desired. Simple horizontal tank design. Less media wear.

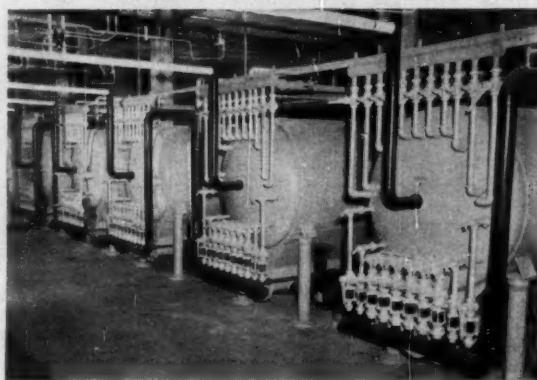


An all-new vertical leaf, fully enclosed tank-type filter

Exclusive Design Features

- A** Internal sprays sluice filter. Can be independently valved for individual operation under low pressure conditions.
- B** No leaking, dripping or air-borne contamination. Assures a neat filter station with clean, sanitary service. Filter may be insulated to minimize heat loss. Can be installed in low headroom, small floor space areas.
- C** Vertical rectangular leaf design assures maximum flow per filtering area and even precoating. Unexcelled rigidity and durability. Hung on roller carriages for easy individual inspection or removal, no bolts or fastenings. Self-sealing in filter. Stainless steel leaves covered with long-life synthetic cloth or stainless steel wire screens.
- D** Bolted cover on double-hung hinge provides full access to interior without leaf removal. Hydraulic quick-opening cover optional.
- E** Individual plate outlet control valves, sight glasses and sample cocks. Any plate or plates may be shut off without removing filter from service.
- F** Trough bottom with screw conveyor discharges cake neatly and quickly without opening tank. Cake can be reslurried if desired.

SIZES UP TO 1020 SQ. FT. OF FILTERING AREA



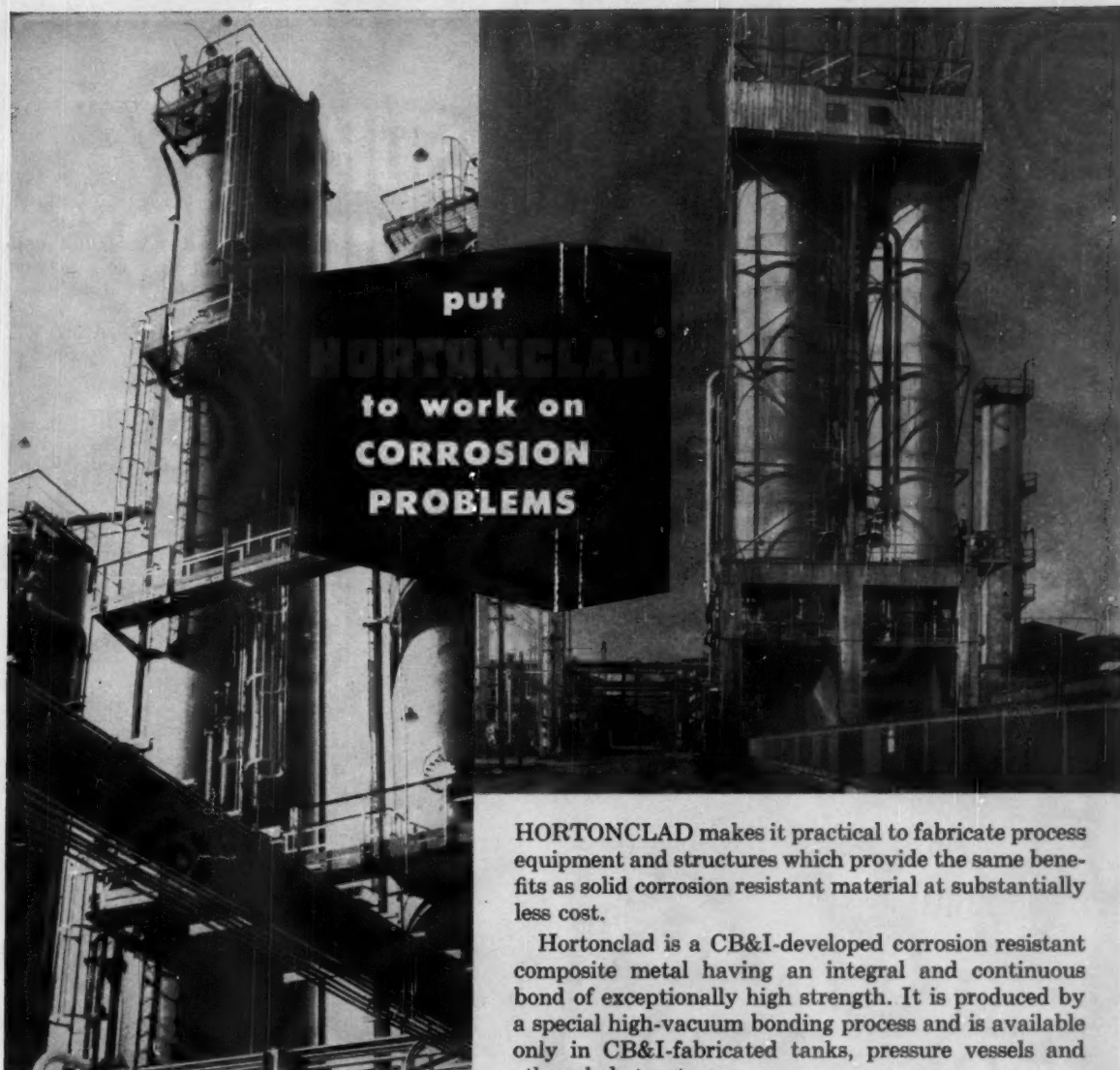
A battery of five 300 sq. ft. Model RSC filters in operation

SPARKLER

MANUFACTURING CO., Mundelein, Illinois, U.S.A.

Sparkler International Ltd., Leliegracht 9, Amsterdam-C, Holland
Manufacturing plants in Canada, Holland, Italy and Australia

Filtration engineering and manufacturing exclusively for over 30 years



(Above)

ABSORBER TOWER at a Louisiana chemical company has stainless steel Hortonclad shell. Thickness of backing and cladding is $1\frac{1}{4}$ inches.

(Right above)

COKING CHAMBER at a Kansas refinery uses 405 stainless steel Hortonclad backed by A205 Grade A moly steel.

HORTONCLAD makes it practical to fabricate process equipment and structures which provide the same benefits as solid corrosion resistant material at substantially less cost.

Hortonclad is a CB&I-developed corrosion resistant composite metal having an integral and continuous bond of exceptionally high strength. It is produced by a special high-vacuum bonding process and is available only in CB&I-fabricated tanks, pressure vessels and other clad structures.

Silver, stainless steels (both chromium and nickel) nickel and alloys such as Monel, Inconel, Hastelloys B and F and a variety of other alloys may be employed in the Hortonclad process. Write our nearest office for a copy of the CB&I bulletin which describes:

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.)

New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City

San Francisco • Seattle • South Pasadena • Tulsa

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY, GREENVILLE, PA. and at NEW CASTLE, DELAWARE.

In Canada: HORTON STEEL WORKS LTD., TORONTO, ONTARIO
REPRESENTATIVES AND LICENSEES:

Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland

SUBSIDIARIES:

Horton Steel Works Limited, Toronto; Chicago Bridge & Iron Company Ltd., Caracas;
Chicago Bridge Limited, London; Sociedade Chibridge de Construcões Ltda., Rio de Janeiro

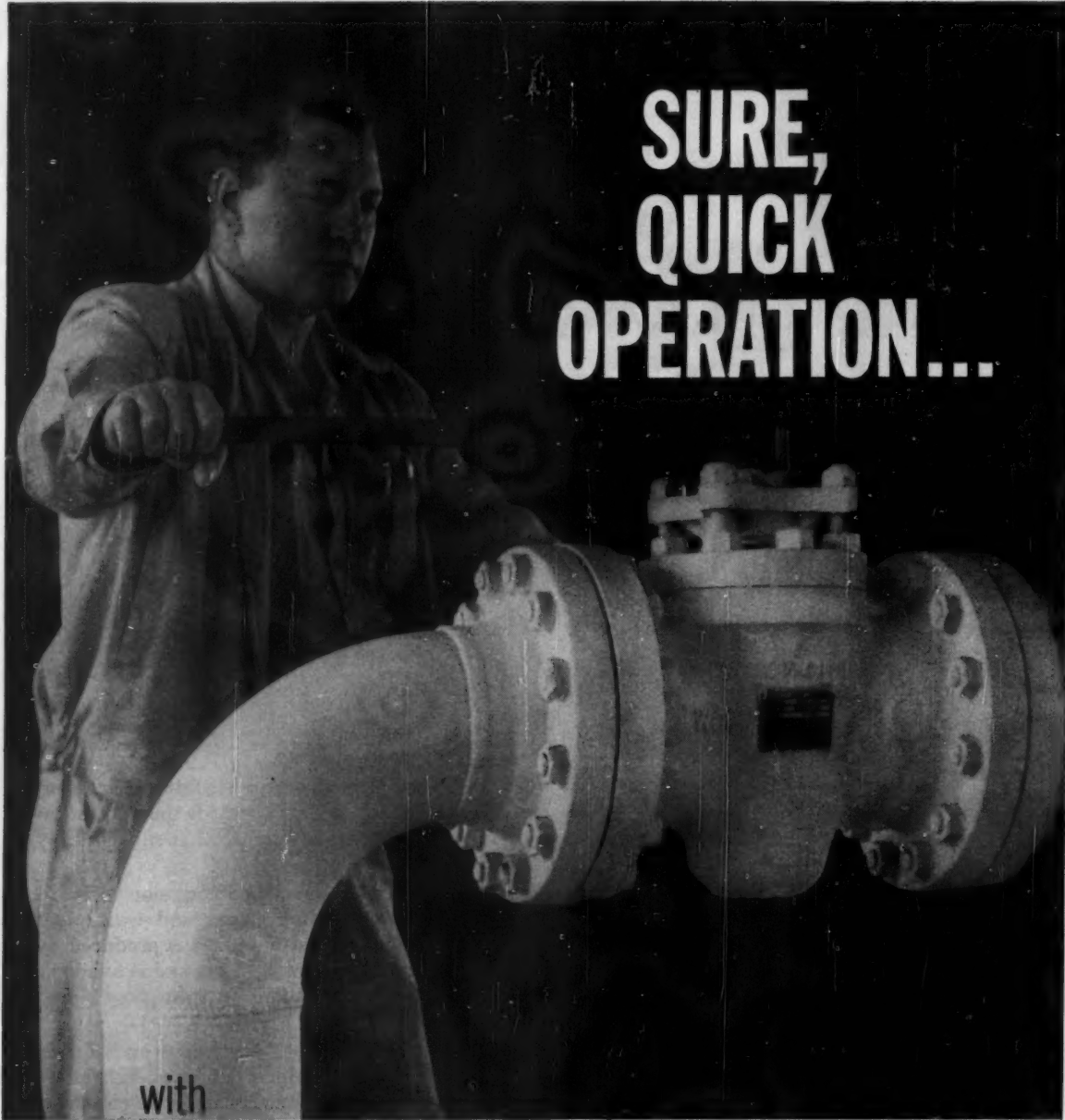


... the benefits of HORTONCLAD

1. Corrosion resistance
2. Economy of design
3. Uniform thickness of clad and backing plate
4. Integral and high strength bond
5. Wide selection of cladding materials
6. Clean contaminant-free surface



C&I



SURE, QUICK OPERATION...

with

WALWORTH LUBRICATED PLUG VALVES

Where closures must be 100% tight, where operation must be quick, where minimum maintenance is a must, Walworth Lubricated Plug Valves should be your first choice. Tight: because the lubricant seals the valve against leakage. Quick operation: a quarter turn of the plug opens or closes the valve.

Fast: easy lubrication either with Walworth's high-pressure Lubricating Gun, or by manually inserting stick lubricant; the valve is easily serviced, even under pressure. Downtime is avoided. For complete information see your Walworth Distributor or write Walworth direct.

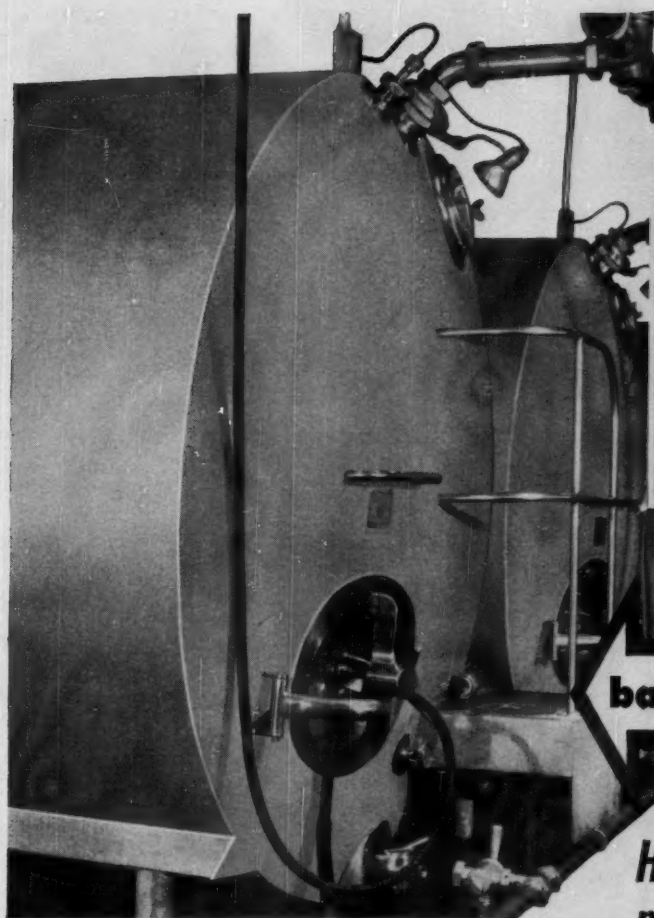


WALWORTH

750 THIRD AVENUE, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO.
MSH VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.



**PAINTED
TONIGHT -**



back in service tomorrow!

*How to reduce maintenance
painting "down time" with*

TYGON PROTECTIVE COATINGS

Now dairymen can carry out protective maintenance—keep equipment looking bright and new—without interrupting production. No need for extended shutdowns or lost production due to painting when your maintenance program includes these companion products:

TYGORUST PRIMER—This unique primer eliminates sandblasting or time-consuming scraping... cuts surface preparation time to the bare minimum... performs equally well on damp or dry surfaces. Its powerful penetrating action goes right through rust, bonds tightly to the steel itself. Dries for recoating within an hour.

TYGON HOT SPRAY PAINT—Made from the same basic corrosion-resistant resins used in Tygon Tubing, Tygon Hot Spray Paint offers important time and cost-saving benefits for dairy use. With hot spray, heat does the thinning so no thinners are required. This gives greater film thickness per coat, less overspray. Saves materials, simplifies masking and clean-up. Tygon can be used through-

out the plant... in areas where conventional cold spray is impractical. It is quick drying, can be recoated within minutes... especially important where scaffolding is required.

Using Tygon, your maintenance crew in most cases can clean, mask, prime, and apply two top coats in one evening. Have the equipment ready for use the next day with no production time lost. Put this high performance team—Tygorust Primer and Tygon Paint—on your maintenance schedule and see how it saves time and dollars for you.



You'll find this free Tygon Painting Manual helpful in solving many maintenance painting problems. Write for it today.

PLASTICS AND SYNTHETICS DIVISION



U. S. STONEWARE

AKRON 9, OHIO

Tygon is a registered Trade Mark of the U. S. Stoneware Co.

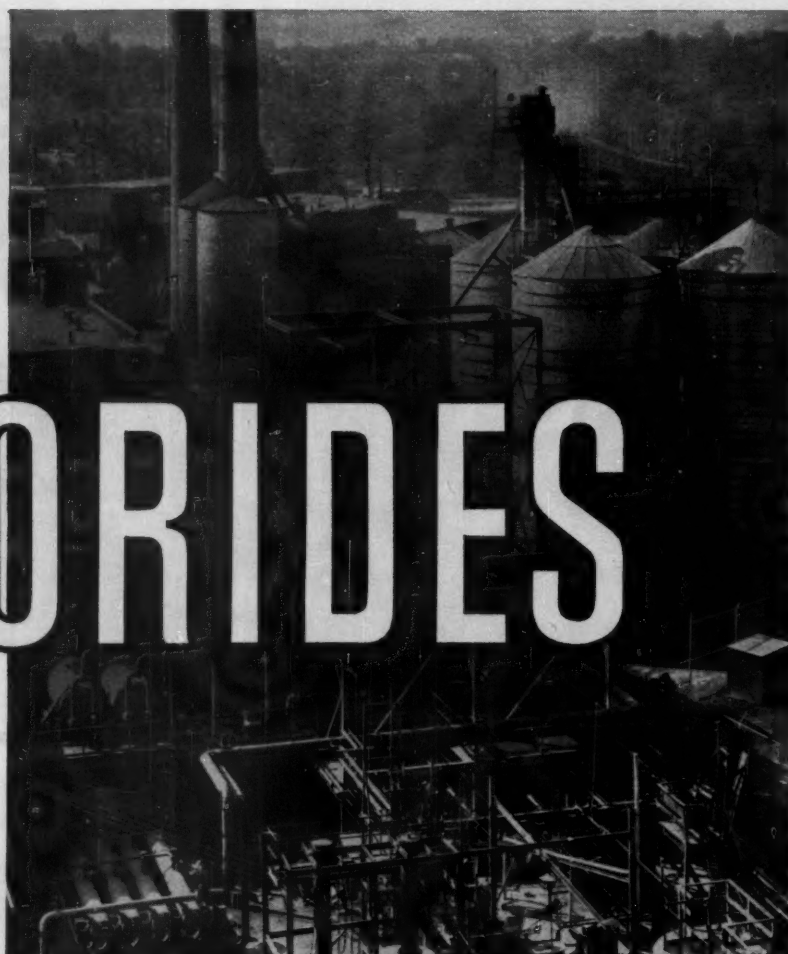
CHEMICAL ENGINEERING—September 8, 1958

231F

49

HARSHAW FLUORIDES

manufactured
in one of the
largest facilities
in the world



Unloading mineral fluorspar which comes to us from various parts of the world.

Write for your free copy of M.C.A.
Chemical Safety Data Sheet SD-25 on properties
and essential information about
HYDROFLUORIC ACID Anhydrous and Aqueous.



BORON TRIFLUORIDE HYDROFLUORIC ACID ANHYDROUS...AQUEOUS

and a long list of other
production-controlled high-quality fluorides

Ammonium Bifluoride
Ammonium Fluoborate
Antimony Trifluoride Sublimed
Barium Fluoride
Bismuth Fluoride
Boron Trifluoride
Boron Trifluoride Complexes
Cadmium Fluoborate
Chromium Fluoride
Copper Fluoborate
Fluoboric Acid
Fluorine Cells
Fluorinating Agents
Frosting Mixtures
Hydrofluoric Acid Anhydrous

Hydrofluoric Acid Aqueous
Hydrofluosilicic Acid
Lead Fluoborate
Metallic Fluoborates
Nickel Fluoborate
Potassium Bifluoride
Potassium Chromium Fluoride
Potassium Fluoborate
Potassium Fluoride
Potassium Titanium Fluoride
Silico Fluorides
Sodium Fluoborate
Tin Fluoborate
Zinc Fluoborate
Zinc Fluoride

If required you are invited to draw on the knowledge and experience of our staff of technical specialists on fluorides.

The Harshaw Chemical Company

1945 EAST 97TH STREET • CLEVELAND 6, OHIO

CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES
HASTINGS-ON-HUDSON, N. Y. • PHILADELPHIA • PITTSBURGH

September 8, 1958—CHEMICAL ENGINEERING



compressor-user survey shows

FEATHER VALVE PREFERRED 2 TO 1!

FEATHER VALVE

VALVE A

VALVE B

A recent survey of compressor users put the amazing Feather* Valve first by far in all four operating categories—simplicity of construction, efficiency, low maintenance cost and quiet operation. In addition, the Feather Valve was picked as the preferred compressor valve 2 to 1 over

the nearest competing type of valve!

The lightest, fastest-acting valve available, the amazing Feather Valve provides very sharp action with virtually no slip or back-flow. It works with no impact . . . has no buffer plates or cushioning devices. Practically indestructible it assures long life with negligible maintenance costs. When buying your next compressor, look into Worthington's complete line of Feather Valve units. Worthington Corporation, Harrison, N. J.

*REG. U. S. PAT. OFF.

WORTHINGTON

NO COMPROMISES

when you select from Worthington's complete compressor line

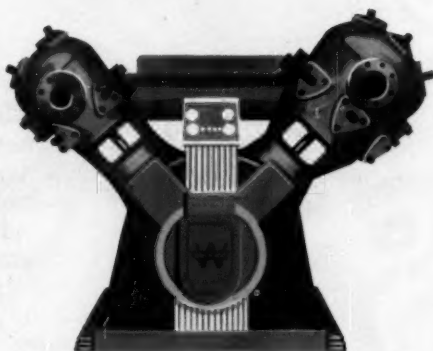
The Worthington line includes a compressor and drive for *every* compression job. Sizes range up to 10,000 hp and gas pressures to 35,000 psi. In addition to the types shown below, Worthington builds many others including steam engine, steam turbine, and engine driven machines in many types and sizes. For more information write specifying the bulletin noted below to Worthington

Corporation, Section 36.1, Harrison, N. J. In Canada: Worthington Canada Ltd., Brantford, Ont.

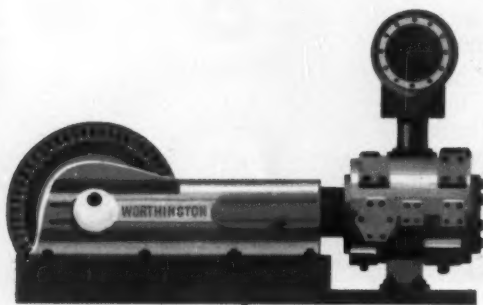
WORTHINGTON



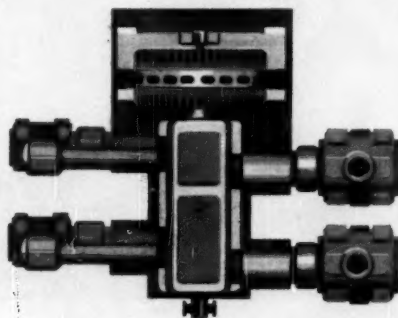
Single horizontal compressor, type HB
5 to 150 hp—Bulletin L-640-B1E



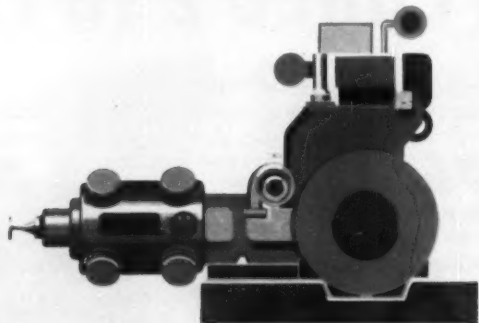
Vertical angle compressor, type YC & DYC
75 to 500 hp—Bulletin L-676-B1A



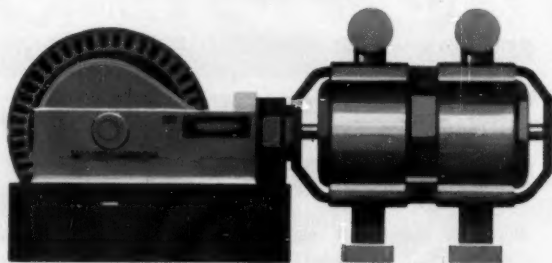
Horizontal duplex compressor, type DC
250 to 3,000 hp—Bulletin L-675-B1C



Balanced opposed compressor, type BDC
400 to 10,000 hp—Bulletin L-679-B1A



Angle gas-engine compressors, types SLHC and SUTC
375 to 2,500 hp—Bulletin S-550-B27; S-550-B23D



Vacuum pump, 200 to 150,000 CFM—Bulletin L-600-B9-4

DEVELOPMENTS...

SEPTEMBER 8, 1958

Chementator

C. H. CHILTON

Imperial Chemical Industries will use a Scientific Design process in its new 30-million-lb./yr. terphthalic acid plant. Available evidence indicates that process is same as that to be used by Amoco, viz., liquid-phase air oxidation of xylene.

Giant calcium carbide furnace—40,000 kw.—will soon go into operation in Germany. Knapsack-Griesheim, subsidiary of Hoechst, claims it is biggest carbide furnace in the world.

Research vs. recession: "Research probably never has been more important to our immediate and future welfare than in this present era of extreme competition," affirms Dow's recent annual report. But company decries increased competition from Johnny-come-lately chemical producers "with well-known processes and thus with no research and engineering costs to be recovered."

Foam separation recovers trace metals

A new chemical engineering tool—foam separation—may soon emerge from the laboratories of Radiation Applications Inc., New York, where an AEC-sponsored research project is delving into the problem of removing radioactive ions from nuclear process wastes.

Foam separation of metal ions is the brainchild of Columbia University's Elmer Gaden, author of a *CE* Report on "Foams in Chemical Technology" (Oct. 1956, pp. 173-184). It involves the addition of a suitable complexing agent (e.g., chelate) to an aqueous solution of metal ions. To be "suitable," the complex must be surface-active. The solution is then blown with gas (air, nitrogen, etc.) to produce a foam which can be readily separated mechanically from the bulk liquid.

The collapsed foam contains the desired metal ion in a higher concentration than the original and residual solutions. RAI has obtained single-stage enrichment factors (concentration in foam ÷ concentration in bulk liquid) as high as 40.

Technique is most effective, says Gaden, when the substance to be removed is present in low concentrations. He sees foam separation as a supplement, rather than a competitor, to conventional separation techniques like crystallization, ion exchange and solvent extraction. It would be used commercially to obtain higher product purities than would otherwise be economically feasible.

Atom bombs, from bane to blessing

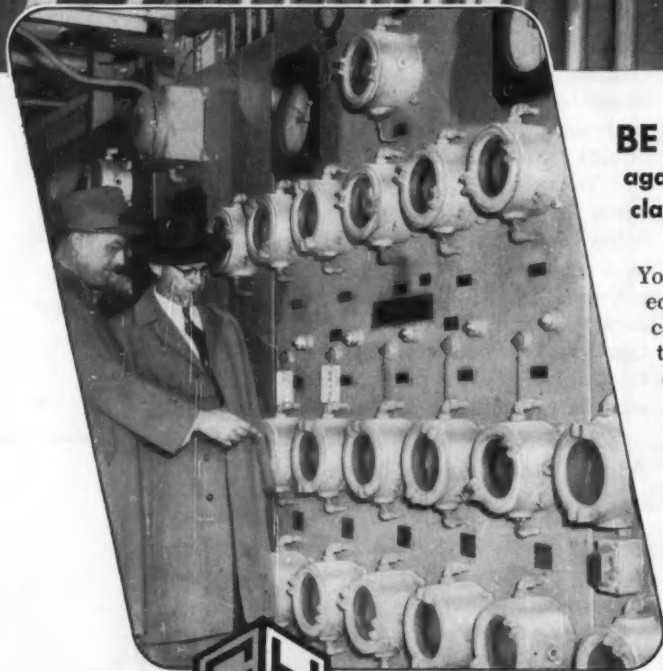
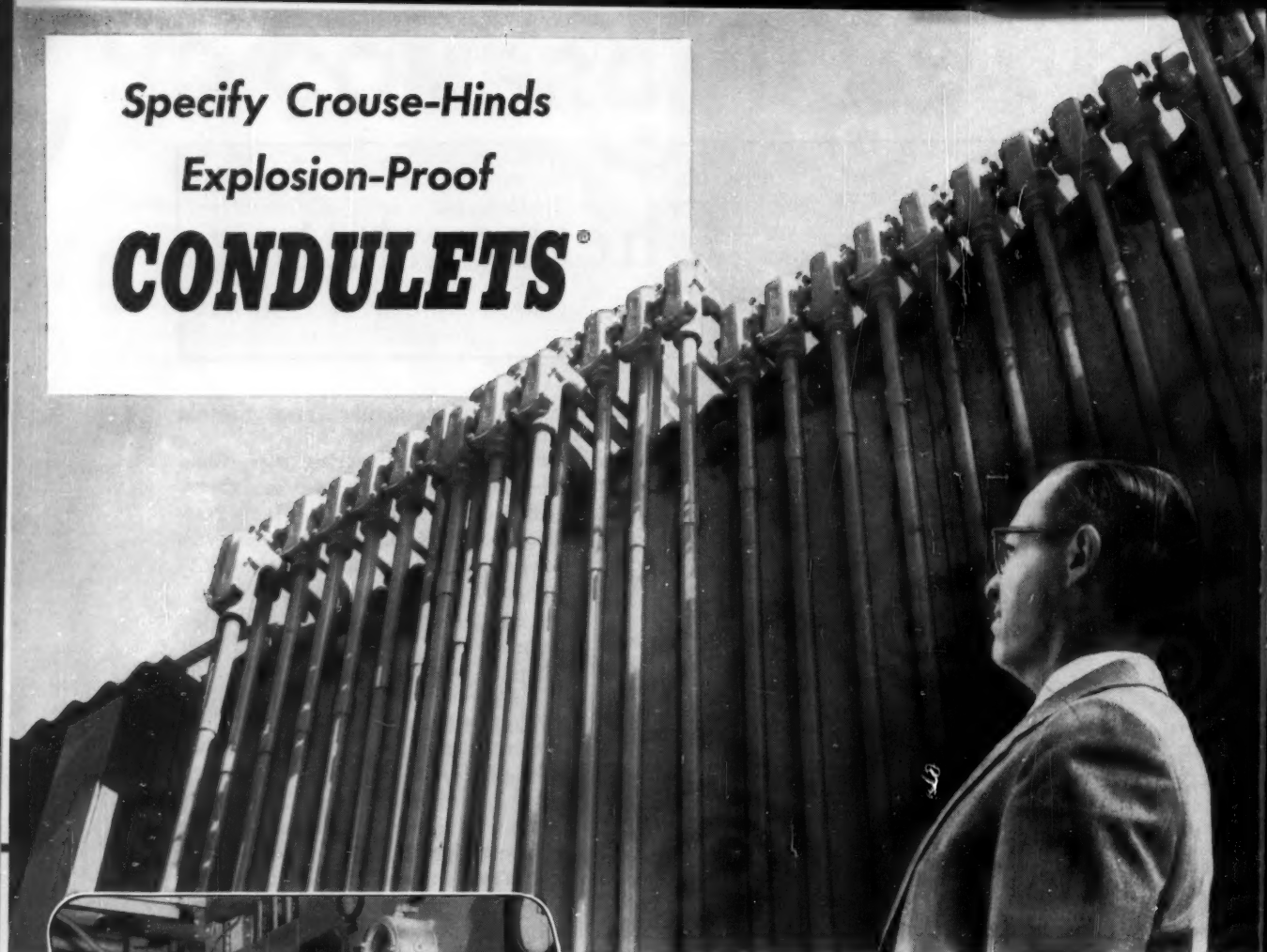
Atoms-for-peace may involve underground bomb explosions as well as nuclear power reactors. These proposed projects are getting serious study:

- Recovery of oil from Alberta's tar sands. Heat from an underground bomb would thin out the oil and make it pumpable.

- Production of power and isotopes by an underground explosion in a New Mexico

(Continued on page 55)

Specify Crouse-Hinds
Explosion-Proof
CONDULETS®



BE SAFE! Rely on Condulets for full protection against electrically-ignited explosion—in any area classified hazardous by The National Electrical Code.

You'll find Condulet Explosion-proof electrical equipment in the nation's leading plants — from complex instrument enclosures like those on the panelboard (at left), to simple pulling elbows on the branch circuits (above). You'll like Condulet equipment because it installs easily, works right, and stays on the job for years without attention.

There are more than 15,000 Condulet items: conduit fittings, plugs and receptacles, motor controls, lighting fixtures, switches, hundreds of others, both explosion-proof and conventional. Make your selections with confidence. You get the best when you get Condulets.

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salt bed. Isotope production would involve surrounding the bomb with various materials which would undergo change through nuclear reaction. Means for power recovery are still indefinite.

- Excavation of a harbor in Northwest Alaska, north of the Arctic Circle.

The tar sands program seems to have advanced beyond the talking stage, although definite planning is being kept secret in Canadian government and oil circles.

Vibrating ball mills apply for work

Allis-Chalmers' horizontal vibrating ball mill, under development for years, will make its official debut this month at the American Mining Congress in San Francisco. Initial commercial model will be a tiny 15x15 in., but it will have a grinding capacity comparable to much larger conventional ball mills.

Meanwhile, British manufacturer William Boulton Ltd. has just brought out a vertical vibrating job called the Vibro Energy mill. It is available in 2½x2½-ft. and 5x5-ft. models. Boulton says that the new mill can achieve a given degree of processing in one-sixth the time of a ball mill.

In operating principle, a high-frequency vibrating unit applies rapid rotary oscillation to the grinding chamber about its center vertical axis. Grinding medium vibrates at high frequency at the same time. Advantages claimed: Accurate control of particle size, low power, small floor space and long ball life.

Vibro Energy mills are already in trial commercial use for grinding titanium dioxide, whitening, paints and alkalis. But none is yet in bona fide full-time production service.

New process for making plastic films

A new technique for making film from thermoplastic resins has made the grade, bringing with it three new commercial products and improved varieties of others.

The new products: Films made from polypropylene, nylon-6 and foamed polyethylene. The improved ones: Films of medium and low-density polyethylene which are distinguished by high clarity and gloss.

New Flex-L process was developed by Ludlow Papers, Inc., Needham Heights, Mass. Though unwilling at present to go into process details, Ludlow points out that its new film-forming method overcomes limitations on the

blowing process currently in wide commercial use. Neither polypropylene nor foamed resins can be blown, and the extent to which nylon-6 can be blown is limited.

Foamed polyolefin sheetings represent entirely new, flexible, textured materials. Their insulation values and effectiveness as a moisture barrier indicate that they will compete with foil, plastic laminates and high-grade paperboard.

Polypropylene film is expected to compete in high-gloss packaging applications with cellophane, saran, polyethylenes and some vinyls. Caprolactam-based (nylon-6) film will vie with polyester films on the strength of its heat-sealability, printability and resistance to solvents, greases and alkalis.

Although Ludlow has installed facilities for commercial manufacture of the new films, the company acknowledges that licensing the Flex-L process to other manufacturers may be in the cards in order to realize its potential.

Turn waste pickle liquor into an asset

As pressure mounts to solve the problem of stream pollution from waste pickle liquor, chemical engineers are rising to the challenge with new and improved disposal processes.

Latest to bid for attention is a process offered by Singmaster & Breyer, New York engineering firm. Its claim to fame: Operation at a net profit when handling 100,000 gal./day of liquor.

Total operating cost, including depreciation, is said to be less than the combined values of recovered sulfuric acid (@ \$22/ton) and iron oxide (@ \$10/ton). Estimated total fixed investment: \$2.1 million.

S&B process involved three steps: Evaporation-crystallization to recover acid content of spent liquor and produce ferrous sulfate monohydrate; roasting the monohydrate to produce ferric oxide and sulfur dioxide; contact unit to convert SO₂ to H₂SO₄.

Key step is the first one. S&B has developed (and filed for patents on) a two-stage, low-temperature, low-pressure system (180 F., 6.3 psia., and 130 F., 1.9 psia.) for crystallizing monohydrate under relatively mild corrosive conditions with high thermal economy. Compared with other monohydrate process routes, S&B believes that its evaporation step is better than the spray evaporator of the Koppers-

(Continued on page 58)

P-K "Twin-Shell" Liquid-Solids Blender easily and thoroughly disperses as little as 0.5% by weight of any liquid into dry solids. "Twin-Shell" does it in 15 minutes.

Blend

*100 lbs. fine powder
and 8 oz. liquid
... in 15 minutes!*

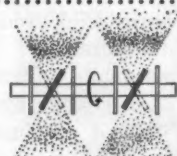
With the P-K "Twin-Shell" Blender the process industries can eliminate such post-blending operations as pulverizing and screening, with their time-consuming materials handling. Blending time itself is cut from hours to minutes. And some hitherto impossible blends are achieved easily with the P-K "Twin-Shell." Here's how "Twin-Shell's" unique design speeds processing:



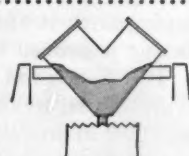
CHARGE DRY SOLIDS through top of either shell. Optimum charge level for most materials is about 65% of total shell volume.



TUMBLE AND AERATE. As shell revolves, rapidly spinning wire cage intensifier breaks up agglomerates, literally creates dust storm in material.



ADD LIQUID. Centrifugal force sprays atomized liquid from periphery of control discs on Liquid-Feed Bar into finely dispersed solids.



DISCHARGE PRODUCT easily through apex of shells. Accessibility of interior and easy removal of Liquid-Feed Bar speed cleaning.

See this new concept in blending! Accept this invitation... ➡ ➡

Get new ideas for your blending process at P-K's Pre-Test Lab

Phone Stroudsburg 820 and arrange
to make comparison tests — using
your own formulations — at
P-K's Pre-Test Lab.

P-K makes practically all kinds of blenders — conventional types as well as the radically different "Twin-Shell." Thus, P-K can give you impartial help in selecting the correct blending process for your needs.

But, blending is full of variables; don't decide on *any* blending equipment or process until you pre-test it with your own formulations. The Pre-Test Lab offers you an opportunity to do this with the aid of skilled blending technicians and proper equipment . . . and without obligation, of course.

You simply bring or send your materials to the Lab. Here the correct blending procedure and equipment for *your* job are determined by extensive tests. You receive a comprehensive report that can become the basis for an informed selection.

You're invited

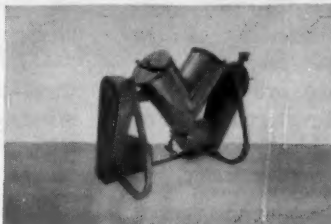
to pre-test your own formulations at the Pre-Test Lab. Write — or better yet, phone — Russell Dotter at P-K to set a date. (The number: Stroudsburg 820.) He will tell you how much of your materials to bring and will give you other details.

If you can't spare the time, send your materials anyway. But try to see the tests for yourself. If your process includes precision blending, your visit will be worth your while. The Patterson-Kelley Co., Inc., 1509 Hanson St., East Stroudsburg, Pa. (in the heart of Pennsylvania's scenic Pocono Mountains).

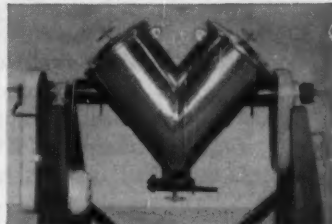
P-K Process Executive welcomes visitor to Pre-Test Lab at East Stroudsburg, Pa. Lab is equipped and staffed to make, or help you make, conclusive tests of blenders with your own materials.



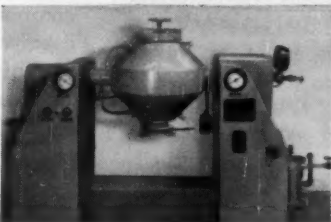
TEST YOUR MIX WITH EQUIPMENT LIKE THIS



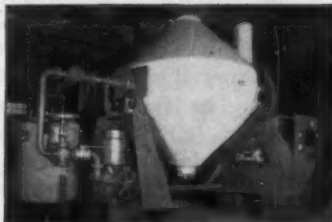
"Twin-Shell" Liquid-Solids laboratory models are made in transparent Lucite or stainless steel, in 8 and 16 quart sizes.



Production models of the "Twin-Shell" blender range up to 50 cu. ft. capacity. (Intensifier and Liquid-Feed Bar optional.)



Vacuum Tumble Dryers by Patterson-Kelley are available in sizes down to the standard 1 cu. ft. capacity lab model.



Production models of the Vacuum Tumble Dryers have capacities up to 150 cu. ft. Come factory aligned, piped, instrumented.

Patterson Kelley
Chemical and Process Division

Zahn process (*Chem. Eng.*, Aug. 1957, pp. 168-170) or the vapor-recompression falling-film evaporator of the Belle Fons process (*Chementator*, July 14, 1958, p. 76).

The Hoak process (*Chementator*, July 28, 1958, p. 53), like S&B, promises disposal of waste pickle liquor at a profit. However, since it involves reaction with coke-oven gas to produce ammonium sulfate and other products which cannot be used within the steel mill, its potential utility is limited.

Moving-grate kiln broadens its base

With two cement mills operating successfully on the ACL system for burning clinker (*Chem. Eng.*, Apr. 21, pp. 60-62), Allis-Chalmers now aims to extend this technique to heat-processing of other materials, such as phosphate rock, bauxite and iron ore.

A new \$250,000 pilot plant to explore such applications is due to start up next month at Carrollville, Wis. It provides greater versatility and adaptability to a wide variety of different materials and operating conditions than did the original ACL cement pilot plant.

Calcining of phosphate rock and agglomeration of iron ore fines are areas of immediate commercial interest. A-C has letters of intent from two major iron ore producers who believe that the ACL combination of disk pelletizer, moving-grate dryer-preheater and rotary kiln can agglomerate ore fines.

A-C will also attempt direct reduction of iron ore in the new pilot plant. Company expects technical answers, by next summer.

Closed fuel cycle aims to cut costs

With cost of reprocessing spent fuel looming as a major hurdle in the road to economical nuclear power, Argonne National Laboratory's program for piloting a closed fuel cycle takes on special significance.

The 20,000-ekw. experimental breeder reactor (EBR-II) now under construction at Arco, Idaho, will incorporate a \$9-million facility for melt-refining spent fuel and remotely fabricating the recovered uranium into replacement fuel elements. Reprocessing plant is slated to be ready shortly after EBR-II is completed late next year.

Fuel will consist of several hundred kg. of 50%-enriched uranium metal in the form of thousands of pins, 0.14 in. dia. and 14 in. long, each contained in a stainless steel can. Spent

fuel purification involves decanning of fuel pins, chopping them into short pieces, melting the metal and holding it in a zirconia crucible for 3-4 hr. at 1,300 C.

Under these conditions the volatile fission products (Kr, Xe, Cs, Sr, Ba, Cd) vaporize and are collected on Linde molecular sieves. Some of the other metals react with the crucible surface to form an easily separable slag. Less reactive elements (Mo, Ru, Tc, etc.) stay in the reprocessed fuel and will comprise about 5% of the total fuel weight.

Aqueous reprocessing methods—which usually involve dissolving the spent fuel in nitric acid and solvent extraction of the nitrates—are clean and effective, but costly. Pyrometallurgical processes, such as Argonne's melt refining, are inherently simple and economical for metallic fuel, but are not yet well developed.

One important unknown is the effect of residual fission products in the recovered fuel. EBR-II and its fuel reprocessing pilot plant aim to find the answers.

Nitric acid makers beat pollution rap

Catalytic reduction of air-polluting, smog-forming nitrogen oxides to harmless, colorless nitrogen is now a burgeoning trend in the nitric acid business.

Latest acid plant to incorporate this feature—St. Paul Ammonia Products, Hastings, Minn.—is due on stream this month. Within the past two years the new technique has been put into use at these nitric acid plants: U. S. Steel (Provo, Utah), Texas Co. (Lockport, Ill.) and Allied Chemical (Hopewell, Va.). A fifth unit is used by Koppers to treat waste gases from niacin production at Arroyo, W. Va.

Principle of operation is the flameless combustion of a gaseous fuel over a platinum catalyst, with the nitrogen oxides supplying part of the necessary oxygen. Products of combustion are nitrogen, CO₂ and water vapor. System was developed by Catalytic Combustion, Detroit.

Catalyst element is made of crimped nickel ribbon plated with a platinum alloy. The element just installed by St. Paul Ammonia cost about \$14,000, handles 15,000 scfm. of waste gas. R. J. Ruff, president of Catalytic Combustion, puts total investment at roughly \$2-3/scfm. of waste gas.

For more on DEVELOPMENTS. 60



Looking for **DOUBLE FLUORIDES?**

Look no further! Your best source for double fluorides (as for most other fluorine chemicals) is Baker & Adamson. Here's why.

B&A offers *seven* double fluorides. They are:

- Chromium Potassium Fluoride
- Potassium Ferric Fluoride
- Potassium Titanium Fluoride
- Potassium Zinc Fluoride
- Potassium Zirconium Fluoride
- Sodium Silico Fluoride
- Sodium Zirconium Fluoride

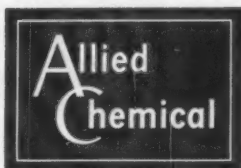
This specialized group of products is part of an ex-

tremely wide range of fluorides manufactured by Baker & Adamson, as part of General Chemical's extensive fluorine program. You expect this scope from General Chemical, with its basic position in elemental fluorine, hydrofluoric acid and their raw materials . . . its manufacturing ability and versatility . . . and its major, continuing research in fluorine chemistry and technology. General Chemical leads today in virtually *every* aspect of fluorine research and production . . . and this specialized knowledge is at your service.

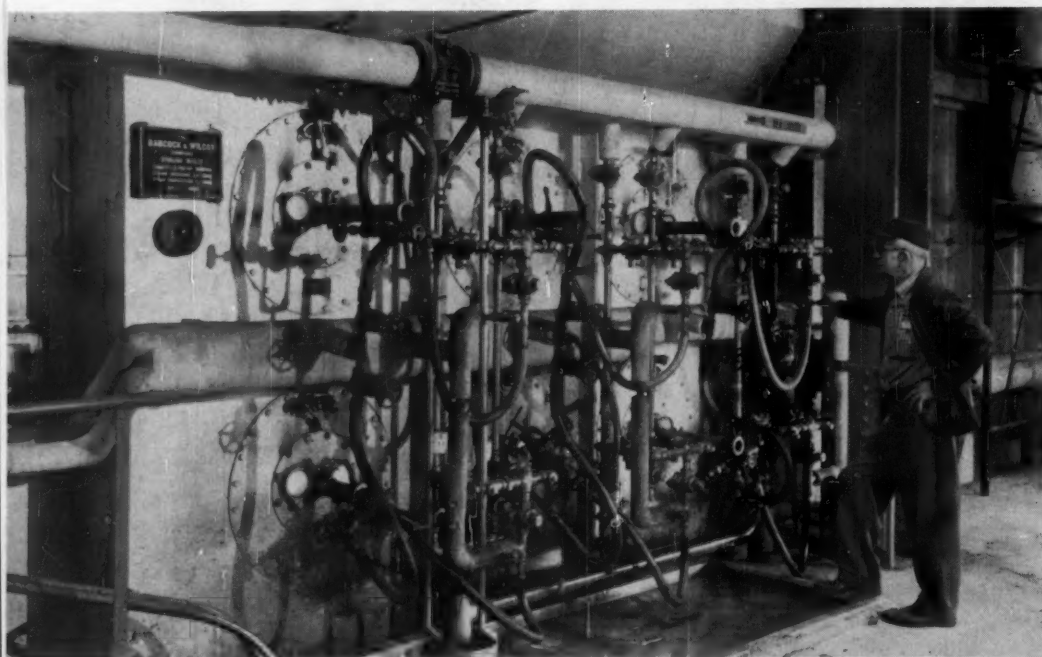
Write today for further information, samples or technical assistance. Company letterhead, please.



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GENERAL CHEMICAL DIVISION
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BURNERS feed concentrated liquor to furnace for liberation of heat and chemicals.

Magnesia Pulping Breaks Pollution Stalemate

- Brown Co.'s shift to magnesia reroutes waste load
- Now, former waste stream feeds recovery unit
- Combustion process yields heat and chemicals
- First in East, process may spark others to follow

Process details appear on foldout flowsheet pp. 114-117

During April, the Brown Co., Berlin, N. H., started continuous operation of magnesia-base pulping and chemical recovery at its 400-ton/day Burgess sulfite mill. First of its type in the East, this \$5.25 million conversion:

- Enables Brown to improve quality of its pulp products.
- Recovers heat and chemicals to improve process economics.
- Reduces flow of waste sulfite liquor into the Androscoggin river.

• Frees the mill from production cutbacks during low-water conditions to satisfy anti-pollution controls.

► **Bypass Old Man River**—Brown's dilemma, which led to adoption of magnesia-base pulping, is shared in various degrees by most sulfite pulp mills operating in the North Central and Northeast states. Manufacturing a line of specialty pulp products by the sodium bisulfite process, Brown had to reduce output at times to avoid overloading the river with waste.

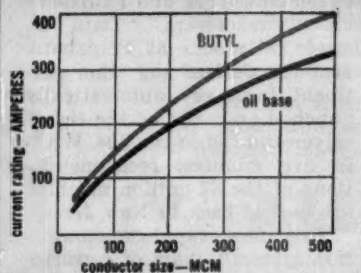
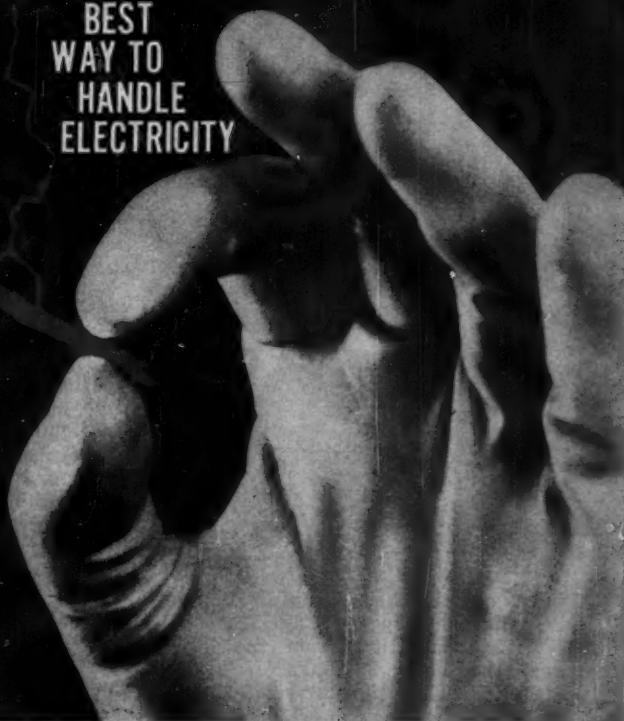
The most positive way for Brown to win complete freedom from the vagaries of the river and enforced pollution controls was to process the waste liquor within the plant to completely destroy its pollution potential. And Brown could meet this objective most completely and economically by converting the mill to magnesia pulping and chemical recovery.

Earlier installations of this process at Weyerhaeuser Timber Co., Longview, Wash., and at Ketchikan Pulp Co., Ketchikan, Alaska, had thoroughly proven magnesia's feasibility.

► **Simple Flame Reaction**—Magnesium bisulfite lends itself to recovery because the waste pulping liquor can be readily concentrated by evaporation without precipitation problems. Then, in the recovery furnace, it

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BEST
WAY TO
HANDLE
ELECTRICITY



Butyl's outstanding resistance to heat allows considerably higher currents for any given conductor size.

Of all vulcanizable rubbers, Enjay Butyl offers the best electrical and dielectric properties. Butyl is the ideal material for wire and power cable, transformers, tapes, bus-bars and other insulation applications.

Butyl also offers outstanding resistance to weathering and sunlight . . . chemicals . . . abrasion, tear and flexing . . . superior damping properties . . . unmatched impermeability to gases and moisture.

Find out how this versatile rubber can improve your product. Call or write the Enjay Company, today!



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changes consisted of replacement of conventional blowpits with blow tanks and new pulp washers.

► **Brown's Firsts**—Similar in principle to systems at Weyerhaeuser and Ketchikan, Brown's facilities possess several distinctive features:

- Concentration of waste liquor takes place in a 6-effect Sandvik-Ramen evaporator, first installation of this novel Swedish unit on magnesia base.

- Babcock and Wilcox recovery furnace and boiler is largest single unit built for magnesia recovery, to date, features vertical design to conserve space, recovers more heat than predecessors.

- Absorption system is first to use Pease-Anthony venturi scrubber for recovering SO_2 gas from flue gas.

► **Unusual Evaporator**—Second only in size among Ramen installations to a unit handling calcium bisulfite liquor at Kuusankoski, Finland, Brown's evaporator removes 200,000 lbs./hr. of water from red liquor.

Evaporator effects feature dual construction, external flat-plate heat exchangers and special sealless circulating pumps that favor high-rate liquor circulation to hold down scaling (liquor contains calcium from pulpwood).

Before liquor becomes sufficiently concentrated to produce heavy scaling, it bleeds into a hot, large-volume circulating stream. In pressure heaters, bleed-stream temperature jumps 140 F. instantaneously, precipitating fine, suspended calcium sulfate crystals. This keeps calcium sulfate from crystallizing on heater surfaces of last two effects.

► **Furnace Designed for Magnesia**—Brown's Babcock & Wilcox recovery furnace differs in several respects from the type used for burning kraft black liquor. Since the red liquor burns completely in suspension, there is no smelting zone, hearth or dissolving tank.

A noteworthy feature, related to the burning characteristics of the liquor and magnesium bisulfite, is that no heat is lost by chemical reduction or discharge of molten smelt from the

furnace. All heat of combustion not used to evaporate water is recovered by the boiler. Brown recovers 16,000 lb. of steam for each ton of pulp produced.

Open passes between the combustion zone and superheater allow the gases to cool rapidly so that there is little or no conversion of SO_2 to SO_3 . Also, this rapid cooling brings any sodium or potassium impurities below the sticky range.

► **Venturi Wins New Job**—Both Weyerhaeuser and Ketchikan use packed towers to contact SO_2 in the flue gas with $\text{Mg}(\text{OH})_2$ to make magnesium bisulfite. At Brown, however, after the flue gas is cooled to condense water vapor and permit maximum absorption of SO_2 , it contacts $\text{Mg}(\text{OH})_2$ spray in the throats of two Pease-Anthony venturi scrubbers, forming soluble magnesium bisulfite.

Brown's makeup magnesium is purchased by tank car as concentrated magnesium hydroxide. Sulfur makeup is SO_2 from roasting of pyrites, obtained as concentrates from copper-mine operations.

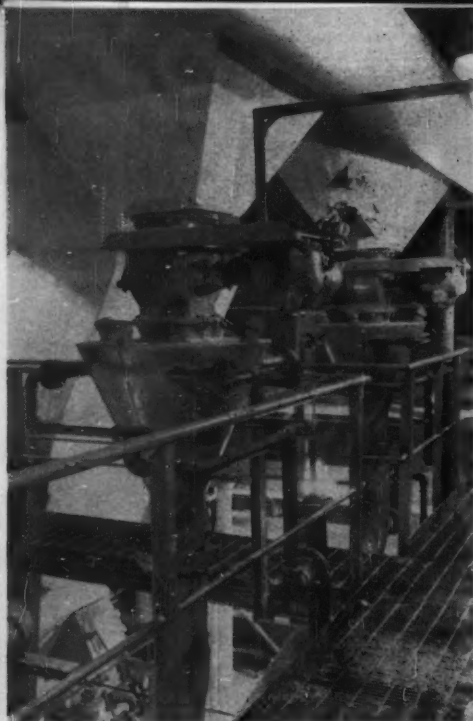
Flow sheet with detailed description of process will be found on p. 114.

Speedy Communications Extend Computer's Reach

Engineers at Socony Mobil Oil Co.'s Paulsboro, N. J., refinery are now finding out how to set refinery runs for optimum product distribution just five minutes after posing the "question" to an electronic transmitting device.

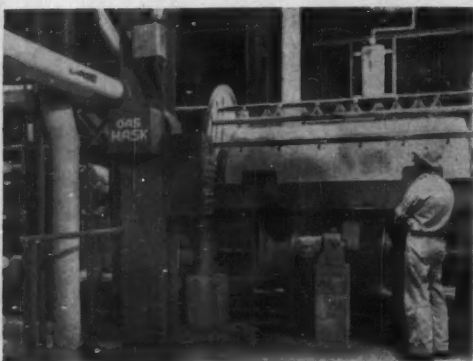
Answers come from Socony's new IBM 704 computer in its New York City data processing center, with data relayed between New York and Paulsboro via "transceivers." Data on crude oil stocks at Paulsboro, products desired and other pertinent facts are automatically punched on cards by the transceiver and fed to the 704. Within five minutes, recommendations of the \$2-million machine are flashed back to New Jersey.

This new rapid-communication system is part of a worldwide computer network being developed by Socony.



STAR feeders control discharge of hot MgO flyash from hoppers.

ROTARY washer removes soluble salts from reslurried MgO flyash.



burns cleanly to gas containing SO_2 and fine suspended MgO.

After separation from the gas, the MgO is slaked to $\text{Mg}(\text{OH})_2$. Then, the slurry contacts flue gas to absorb SO_2 , forming fresh magnesium bisulfite liquor.

Process is much simpler than kraft recovery systems which require extensive causticizing, sludge washing and calcining equipment. It is also simpler, and better proven than known recovery cycles for sodium-base liquor.

A large part of Brown's \$5.25 million was spent to install the recovery plant for processing waste red liquor. Pulp mill



open motors for extreme conditions

Save up to 60%!

Here's an amazing advance in motor technology! It's the *Super-Seal* motor line — an open motor design so completely unaffected by moisture, dust, dirt, oil, acids and alkalis that it can be used in many applications previously requiring more costly enclosed motors. *Savings range from 15 to 60%.*

Super-Seal motor superiority results from revolutionary insulating techniques. Available in any integral horsepower size, smaller *Super-Seal* motors incorporate an encapsulated stator. A durable epoxy resin encloses the stator, creating an electrical system impervious to outside elements.

In larger sizes, *Silco-Flex* insulation is used. In this system, silicone rubber is vulcanized into a homogeneous mass to form a flexible, moisture and heat resistant, void-free dielectric barrier around coils and leads.

Both of these insulation systems are unsurpassed. Proof? An encapsulated motor ran for hundreds of hours at full load in a 4% brine solution.

Find out more about new economies in motors from your A-C representative or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. *Silco-Flex* and *Super-Seal* are Allis-Chalmers trademarks.

ALLIS-CHALMERS



A-5802



Radioisotopes Measure Mercury Inventory

Investing \$200 in a vial of radioactive Hg-203 saves an Australian firm several thousand dollars every time it has to take stock of mercury inventory in its electrolytic chlorine plant at Maryvale, Victoria.

Company, Australian Paper Manufacturers, Ltd., has 24 De Nora cells in its chlorine plant with about 1,700 lb. mercury circulating in each cell (mercury acts as cathode for brine electrolysis and carries liberated sodium out as an amalgam). Periodically, plant personnel must calculate mercury inventory for material balances and accounting purposes.

Former procedure was to drain each cell and weigh the mercury, but this has two drawbacks: Cells don't drain cleanly and valuable production time is lost during weighing.

New technique is based on isotope dilution, enables one man to measure mercury content of all 24 cells in just one day with no down-time and error of less than 1%.

Twenty grams irradiated mercury containing 2 ppm. radio-

active Hg-203 is diluted in 1 kg. natural mercury for safe handling. Stock is then divided into 40-g. portions, one for each cell, with enough left over for a standard.

Operator removes sample of circulating mercury from each cell so that Hg-203 remaining from previous measurement can be corrected for. Then, he dumps 40-g. aliquot into cell and allows it to mix thoroughly, usually about two weeks.

Mercury samples are then dipped from cells, shaken with dilute H₂SO₄ to remove amalgamated sodium, and activity of each sample measured with liquid-jacketed Geiger counter. Difference in count rates between "before" and "after" samples is then a measure of concentration of Hg-203. Knowing amount of isotope added to cell, calculation of total mercury content is relatively easy.

Cost of special measuring equipment was around \$1,100 in addition to the \$200 pricetag of Hg-203. By comparison, the old drain-and-weigh technique cost \$6,000 every time.

Ta-Nb Output Rising, Price Cut in View?

Tantalum and its sister metal, niobium, have been spotlighted in several developments in recent months. But for the engineer eyeing these metals for special applications—tantalum for acid service and niobium for high temperatures—outlook boils down to this:

Despite rising production of these two metals (now in 300,000-lb./yr. range) basic price will remain around \$65-75/lb. For most engineering applications, this pricetag keeps metals in the "blue-sky" category.

Most recent development was Stauffer's announcement that it's building a \$300,000 semi-works plant in Richmond, Calif., to produce tantalum and niobium pentachlorides. (*Chem. Eng.*, Aug. 25, 1958, p. 68).

National Research Corp., Cambridge, Mass., now claims to be producing biggest (110-lb.) and highest purity tantalum ingots by combining secret sponge-production process with its new vacuum-arc melting furnace. Most of NRC's 30,000-lb./yr. output is earmarked for capacitors.

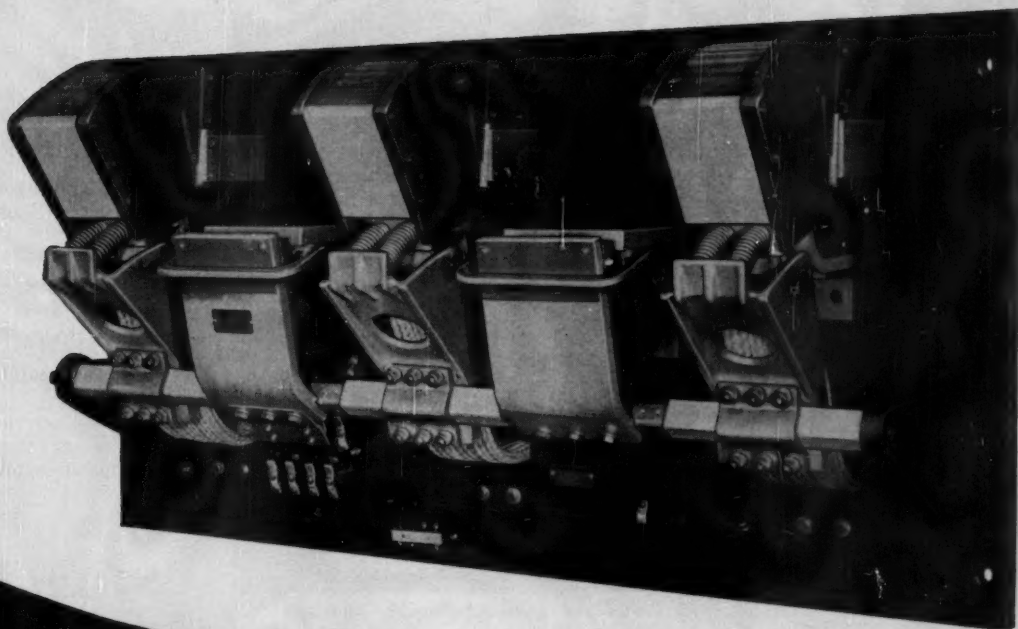
► **More on Niobium**—Du Pont is concentrating on niobium—especially for alloys—and has developed undisclosed process for making niobium sponge. First fruit of its labors is a newly patented high-temperature alloy (80% Nb, 10% Ti, 10% Mo) boasting 11,000 psi. tensile strength in 2,500-F. air-test. Biggest use for alloy will probably be in turbines, especially for rockets and missiles.

All Ta-Nb producers contacted by CE agreed generally on this future for these metals in chemical process applications:

- All producers are aiming at increased ingot size and purity. Bigger ingots will mean lower fabrication costs because less welding is required. But basic metal price will stay around \$70/lb.

- There are probably many spots involving heat transfer in severe acid environment where tantalum might prove economical in long run.

- Niobium will probably find biggest use in high-temperature alloys.



Rugged* Simplicity increases contactor life

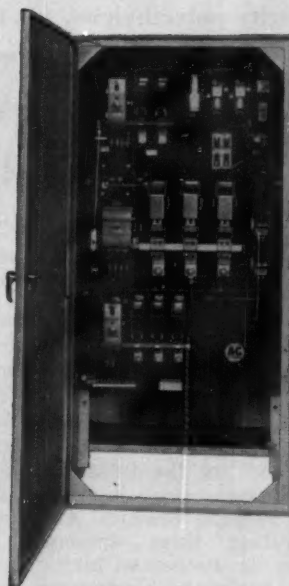
Assures reliability of reduced voltage motor starters

ONE look reveals the clean, balanced design of Allis-Chalmers contactors. Fewer parts eliminate many potentially troublesome areas—mean less wear. Simple, solid construction and high interrupting capacity are positive assurance of reliability.

When you specify reduced voltage starters be sure to get the reliable, long life features provided by Allis-Chalmers contactors. It is these contactors that make all 600 volt Allis-Chalmers Size 4-8 reduced voltage starters the dependable performers they are.

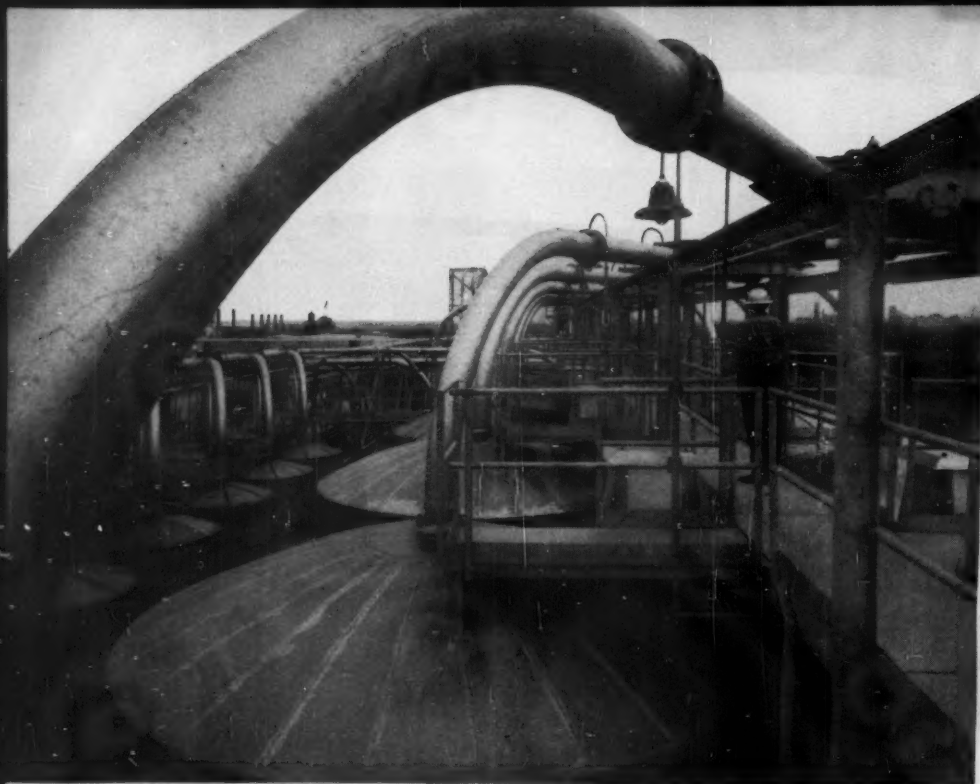
Get all the facts. Call your nearby A-C sales office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

* 7th meaning, Webster's New Collegiate Dictionary, Second Edition.



K-5784

ALLIS-CHALMERS



LOADING LINES of automatic conveyor system, of up-to-date design, provide . . .

For Flake and Pellet, a Clean, Smooth Ride

Improved pneumatic conveying setup now handles high-purity polyethylene. It features closed systems for purity and "rough" piping for smoother flow.

Need for low-cost, highly efficient bulk handling of polyethylene has lately led nearly a dozen polyethylene producers and consumers to adopt the latest techniques in pneumatic conveying.

Though pneumatic conveying has long been available as a materials-handling tool (*Chem. Eng.*, June 2, 1958, pp 114-118), recent developments make it particularly suited to handling such highly pure materials as polyethylene which tend to smear or "ribbon" on the inside of conveyor pipes.

Now, Phillips Chemical Co., incorporating these developments in its up-to-date, highly flexible, pneumatic - conveying system at its high-density polyethylene plant at Adams Terminal, Pasadena, Tex., has revealed nearly complete details on its materials-handling setup.

► **Noteworthy Features** — Designed and built by Fuller Co.'s Dracco Div., the conveyor system—one of the largest ever installed—boasts these noteworthy engineering features:

- Closed-system conveying—in which an inert gas is used as conveying medium to insure contamination-free handling of "fluff" polyethylene. Recycling setup purifies gas.

- Aluminum piping with inside walls roughened by Dracco-patented sand-blasting treatment to reduce smearing of polyethylene on the inside surfaces of the conveying system.

- Extensive use of centralized automatic control and close integration of conveying systems with production.

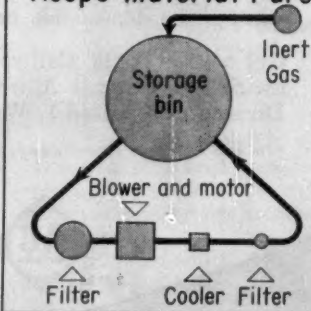
► **From Drying to Shipping**—Over-all conveyor installation handles polyethylene from the time it leaves dryers after poly-

merization until it's shipped to plastics processors. Production operations involved are drying, extrusion, pelletizing, blending and bagging or loading into bulk carriers.

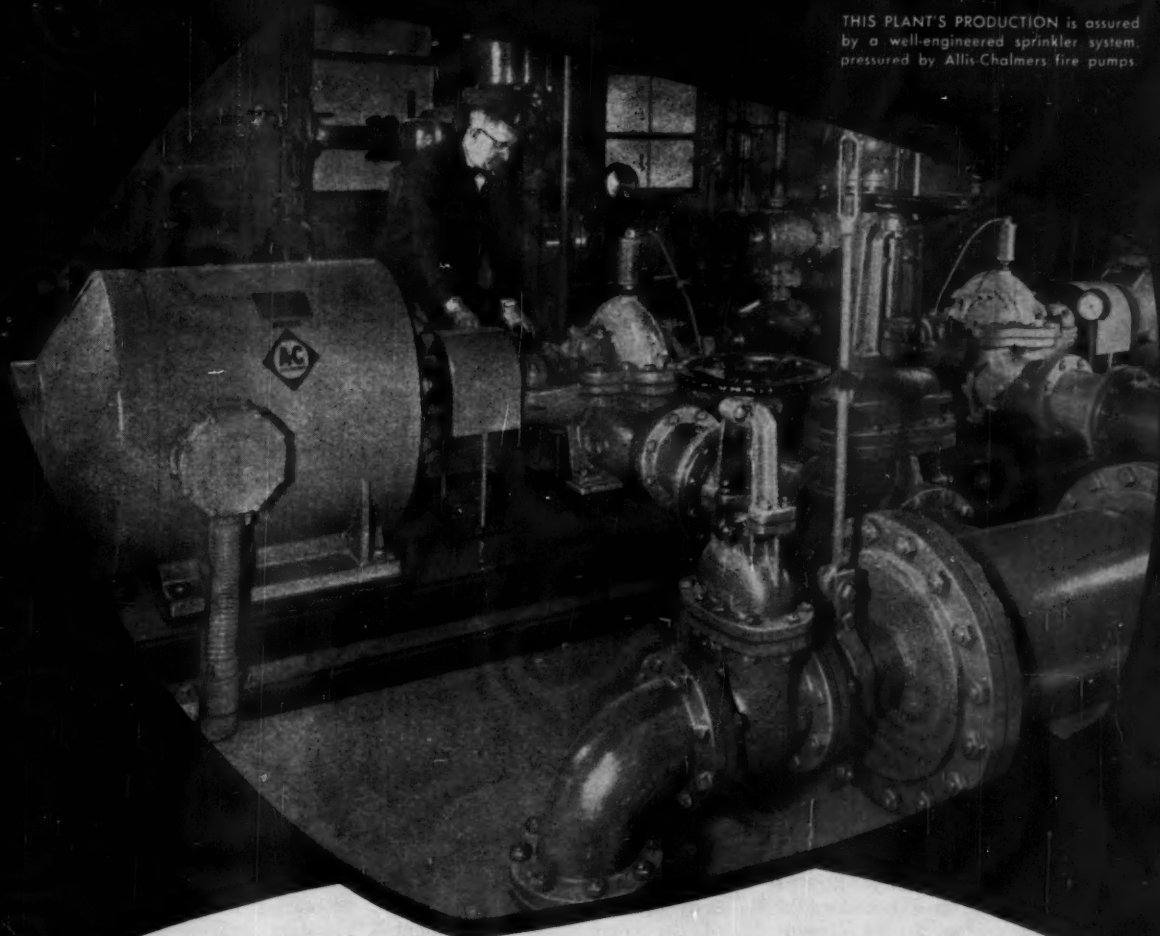
To carry out bulk-handling chores, Phillips uses three main systems, consisting of 13 sub-systems, which are able to handle 45,000-60,000 lb./hr. of polyethylene fluff or pellets.

Main systems are: fluff system which carries polyethylene

Gas Recycling System Keeps Material Pure



THIS PLANT'S PRODUCTION is assured
by a well-engineered sprinkler system,
pressured by Allis-Chalmers fire pumps.



Fire INSURANCE
can't promise plant output!
Fire PREVENTION SYSTEMS can!

Plant damage due to fire can be covered by insurance. Resulting loss of both production and customers, however, is not insurable. Studies show a large majority of companies burned out never get back in business.

Protection begins with prevention. That's why a combination of fire insurance and an *adequate sprinkler system* is a "must" for every plant. And, in addition to safeguarding your continued production, sprinkler protection will:

1. Protect human life
2. Reduce extent of fire damage
3. Reduce fire insurance premiums
4. Give you *more* insurance at less cost
5. Protect non-insurable company data

Necessary components of any fire protection system are dependable pumps. Allis-Chalmers offers a complete line of pumps with capacities to 2500 gpm, heads to 335 feet. All models are approved by Underwriters' Laboratories and Associated Factory Mutual Companies.

Contact your sprinkler contractor or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

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PROCESSES & TECHNOLOGY . . .

a total of 3,000-4,000 lb./hr.

Line filters after each blower assure positive purity of conveying medium, Dracco explains, but they actually pick up little in the way of contaminants. Each filter consists of fifteen 5-in.-dia. cloth bags.

► **A Rough Solution**—Problem that until recently plagued polyethylene makers—smearing or ribboning of material on the inside of piping—has been nearly eliminated at Phillips' plant. When the inside of aluminum piping is sandblasted, Dracco maintains, smearing is sharply reduced (*Chem. Eng.*, June 2, 1958, p. 46).

Sandblasting, explains Dracco's George Schneider, who offered the solution, results in closely packed peaks and valleys on the inside of piping. Particles are slowed down considerably before they contact pipe walls and touch only the peaks, thus cutting down on smearing effect.

Thus, roughness of the pipe supplies an abruptly descending velocity gradient between main body of the airstream and wall of the conduit. This gradient prevents continuous sliding contact of material with wall.

► **High Flexibility**—Besides boasting improved conveying techniques, Phillips' installation has the distinction of being the most comprehensive one

ever designed and fabricated by Dracco.

Each of the three main systems is controlled from a master control panel and is closely integrated with production. Systems are completely interlocked to block out control equipment on panels which may conflict with a given operation.

In case of jamming, systems automatically shut down.

► **Complexity**—One system—the fluff conveyor—has been described above. Here's a brief run-down on the other two main systems:

- Pelletizer-to-storage system has six subsystems which carry pellets to any of twenty-six 45,000 lb.-capacity bins, some of which are 600 ft. away from pelletizing operation. Capacity is 3,000-5,000 lb./hr.

- Transfer system, or storage - to - bagging - and - blending system has three subsystems. First subsystem can move material from any 45,000-lb.-capacity storage bin to any other of the same size, to any 135,000-lb.-capacity bin or to bagging or blending. Second system moves material from 135,000-lb.-capacity bins to blending. Third system moves blended material from blending to either 45,000-lb.-capacity bins or 135,000-lb. bins.

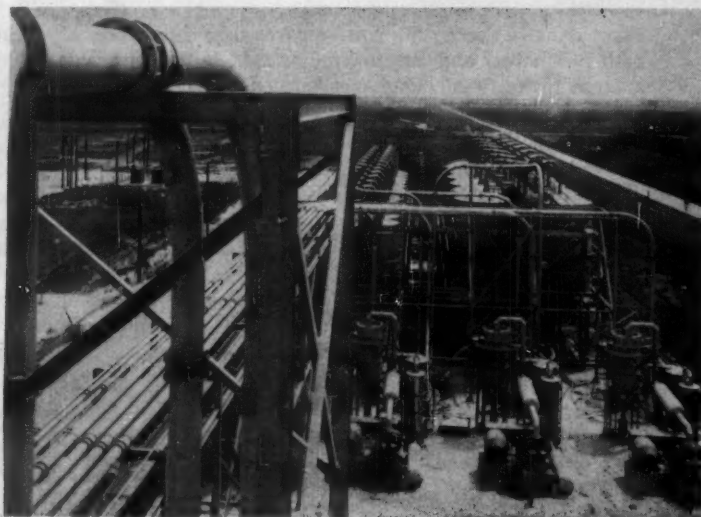
And many of these operations can be simultaneous.

DRYER starts fluff through system; inert-gas maintains purity.

from dryers to storage prior to extruding and pelletizing; pelletizer-to-storage system which conveys pellets to intermediate storage bins; highly versatile storage - to - bagging - and - blending system which can take on a variety of blending and bagging or bulk loading tasks.

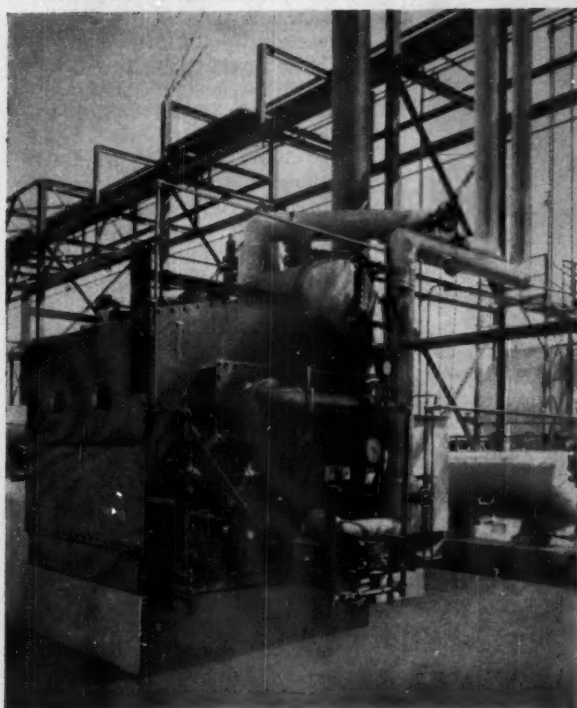
► **Inert Gas for Purity**—Key to contamination-free handling in the fluff system is the closed-circuit technique using nitrogen as conveying medium (see diagram on previous page). Generators supply nitrogen to maintain system volume in each of four subsystems which convey fluff. These systems can handle

THREE SUBSYSTEMS for blending and bagging boost versatility.



During the past **23** years
ONE large chemical company
has installed **54**
FW VAPORIZERS

... with a total capacity of **310,619,000 Btu/hr**



Typical outdoor installation of a 2,000,000 Btu/hr FW Vaporizer using Dowtherm.

REPPEAT orders from satisfied customers account for the majority of Foster Wheeler's business in the process heating field. For example, one large chemical company has been using FW Vaporizers for 23 years. They now have installed 54 units with a combined capacity of 310,619,000 Btu/hr.

In this specialized process heating equipment, the importance of Foster Wheeler's quarter-century of experience cannot be overemphasized. FW Vaporizers using Dowtherm* have been supplied for over 600 installations in sizes ranging from 44,500 Btu/hr to 45,000,000 Btu/hr.

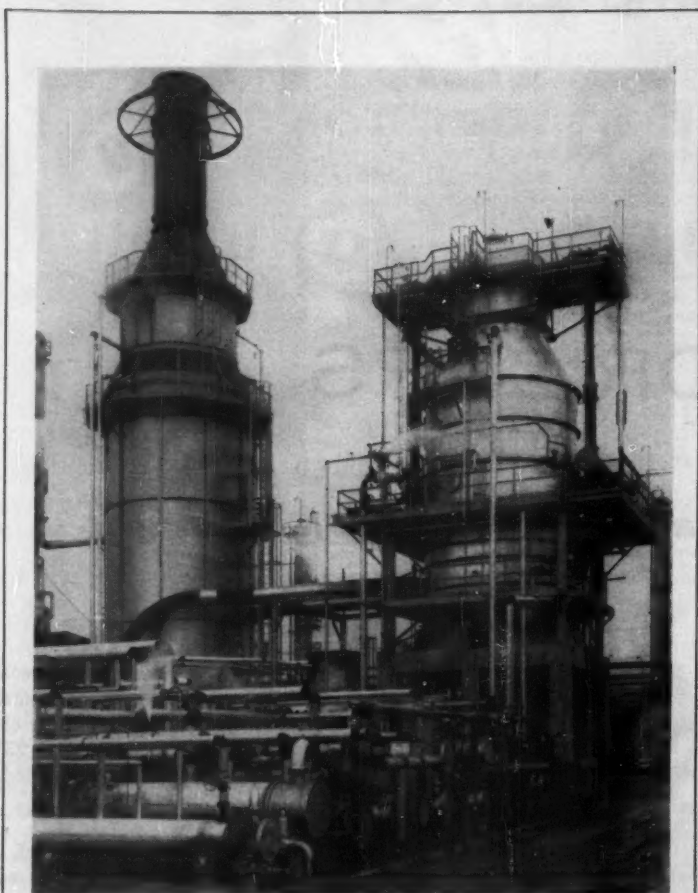
Based on this experience gained in hundreds of applications to different processes, FW analyzes your *entire process heating system* before recommending a design. FW then does the complete job — designs and builds the Vaporizer, installs it in your plant, puts it "on stream" and makes sure that everything functions at top efficiency.

For information on the equipment best suited to your process heating requirements, write to Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

*Reg. Trade Mark, Dow Chemical Co.

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New Vacuum Unit Turns Out Asphalt, Cracking Feed

This combination of heater (left) and vacuum tower (right) at Ashland Oil & Refining Co.'s Canton, Ohio, refinery will process 15,000 bbl./day of bottoms from crude unit, produce feed stock for cat cracking and

large quantities of asphalt for Federal Government's highway program. Units were designed and constructed by Blaw Knox's Chemical Plants Div. under a contract which includes cat reformer and hydrodesulfurizer.

Newest Advances Brighten Hopes for Oil From Shale

Prospects for shale-oil production have now brightened considerably with Denver Research Institute's latest report on economic feasibility of modified Aspeco process to tap the U. S.'s vast reserves of shale oil. Adding glitter: A coupled announcement by project's sponsor, Oil Shale Corp., Carson City,

Nev., of a proposed issue of convertible debentures.

Studies made with DRI's 24-ton/day pilot plant at Denver, Colo., indicate that shale-oil produced in Colorado could be pipelined to West Coast refineries at a cost of \$1.42-\$1.92/bbl. **► Kiln Keys Route**—Heart of DRI's process is a horizontal rotating-kiln retort which tumbles heated aluminum-oxide spheres with crushed shale, heats shale

in the absence of air to pyrolysis temperature (about 1,000 F.) of organic matter in the rock. About two-thirds converts to vaporized shale oil; 10%, to gas and the rest, to solid coke deposit on the spent shale.

After shale oil is condensed, byproduct gases are separated into liquefied petroleum gas and fuel gas with a heating value of 700-1,000 Btu./cu ft.

Cooled aluminum-oxide spheres and shale coke are separated on a screen, and shale coke is burned to reheat spheres for recycle to kiln. Shale coke gives enough heat so that some can be used for plant power and as excess for sale.

Bimetal-Reduction Setup Wins High-Purity Hafnium

U. S. Bureau of Mines has scaled up its high-purity hafnium operation at Albany, Ore., and is now turning out 250-lb. batches in its new pilot plant.

Using essentially the same sodium-magnesium bimetallic reduction as in previous 60-lb. batch operation (*Chem. Eng.*, Aug. 1957, p. 141), BuMines produces hafnium sponge in a 30-in.-dia., 70-in.-high furnace. Preliminary results, BuMines reports, are definitely encouraging: Hafnium produced has excellent properties (including fabricability) and about 80% of the sponge can be melted into ingot without intermediate iodide purification.

► Seeks Fused-Salt Route—Too, BuMines is working on another approach to purification problem—long known (but never perfected) fused-salt scrubbing process for purifying hafnium tetrachloride.

In this method, hafnium tetrachloride is fused with sodium and potassium chlorides by heating to about 300 C. Chlorides complex out iron and other metallic impurities, which remain behind along with any hafnium oxides. Pure hafnium tetrachloride is removed from mixture by volatilizing at 600 C.

Advantage of this method is that hafnium sponge produced in this way can be melted directly to ingot without going through iodide purification.

You May Profit From This Book



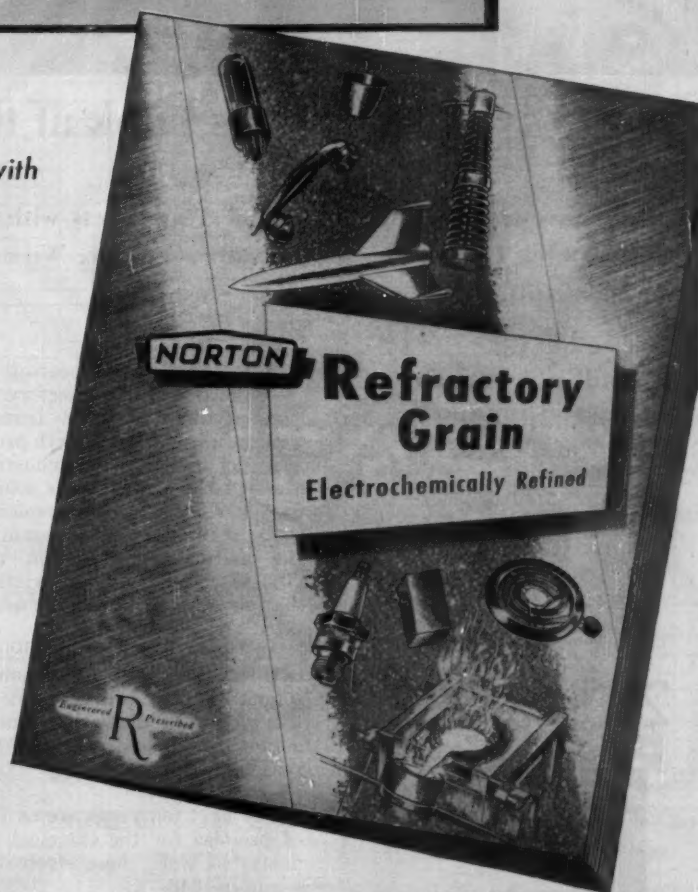
if you are concerned with processing that involves temperatures ranging upwards to 4000°



if your progress in processing depends upon materials of high purity.



if it would help you to obtain a modern material with unusual electrical characteristics.



Here is a valuable reference book that tells you all about the chemical and physical characteristics of such materials as CRYSTOLON* Silicon Carbide, ALUNDUM* Aluminum Oxide, MAGNORITE* Magnesium Oxide, Fused Zirconia and Boron Carbide.

Describing how these electrochemically refined materials react under varying conditions, this book gives you plenty of facts on materials that are helping to solve processing problems.

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*Making better products...
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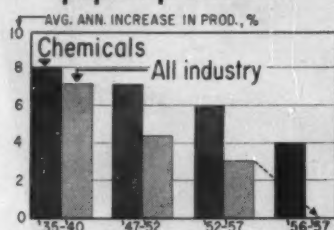
NORTON PRODUCTS: Abrasives • Grinding
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Sharpening Stones • Behr-cat Tapes

Chemical Growth Slowing Down?

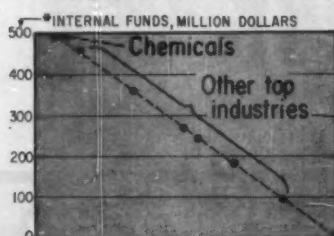
Let's Look at the Facts:

Investors are viewing chemical prospects with a cautious eye. The bloom's off the rose, some say. We say the signs still point one way: Up—fast.

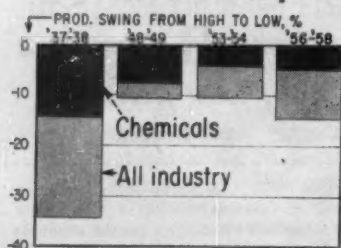
1. Still putting more pep in production



2. Still spending the most* for research



3. Still standing fast in business slumps



WE'VE all been hearing a good deal of conjecture of late—particularly from investment people—about growth prospects of the chemical industry. Much of the conjecture is sobering. It ranges from a suspicion that our industry is approaching full maturity (this from the kindest critics) to a conviction that our industry has been overrated and oversold.

At the risk of oversimplification—a rare fault in economic commentary—I believe most of this gloomy talk is yak. (A lot is deliberately deceptive, too, for reasons best known to the financial world.)

The next ten years are as full of promise for the chemical industry as were those stretching ahead in 1948.

Perspective Is Everything—It's so important to view economic trends in their proper perspective. Don't judge chemical performance absolutely, judge it against all U.S. industries, big and small, old and young.

This is what David L. Babson & Co., a Boston investment counselor, did recently in an appraisal of the chemical future. The firm used many standards: research leadership, growth rate, stability, profit margins, cash flow, pricing, and capacity expansion.

A Babson conclusion: "There is no evidence that long-term trends have turned any less

favorable for the chemical than for any other industry."

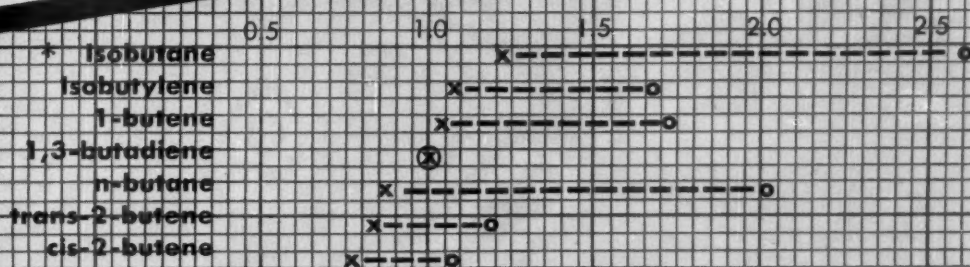
Growth Rate—Critics say annual production increases for chemicals have been slipping since the war years. But this is typical of almost all industries. The chemical industry growth rate is still well above average. Chemical output swelled 4.0% during 1956-57, while all-industry output barely held its own.

Stability—Critics say chemicals have lost much ground in the recession. But the industry has been far more stable these past two years than most industries—just as it has been in past periods of business decline. Chemical production varied only 4.3% from high to low during 1956-58 (to date). All-industry output skidded 14.3%.

Profits—Critics say chemical profit margins have been eroded the past few years. But the "deterioration may be more apparent than real" Average operating margin (profits before depreciation, depletion, amortization and taxes) for 12 leading chemical companies was 23.4% in 1957, compared to 23.7% in 1948-57 and 24.1% in 1952-57. (Heavy depreciation charges have made post-tax earnings appear a little lean.)

Another vital measure of a company's total financial health is cash flow (net earnings plus amortization, depreciation and

QO® FURFURAL extracts Butadiene from C₄ Hydrocarbons Commercially

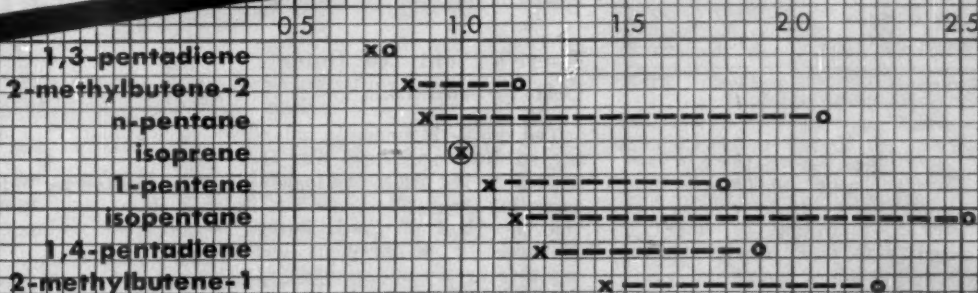


Source: S. B. Bunt, J. O. C. 37, 593 (1947)

X = Volatilities of C₄ hydrocarbons relative to 1,3-butadiene; of C₄ hydrocarbons to isoprene

O = Volatilities of C₄ hydrocarbons relative to 1,3-butadiene in furfural plus 4% water; of C₄ hydrocarbons to isoprene in furfural plus 4% water

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4. Still working with plenty of cash

	% Increase, 1952-57	
	Cash Flow*	Earn- ings*
Allied Chemical	56	4
American Cyanamid	51	57
Dow Chemical	79	39
Du Pont	71	80
Monsanto Chemical	59	17
Union Carbide	60	31

* Per share.

5. Still pocketing a tidy profit

	Operating Margin (% of Sales)	
	Average 1957	Average 1948-57
Allied Chemical	19.9	20.3
American Cyanamid	23.6	19.1
Dow Chemical	29.5	32.2
Du Pont	32.0	34.1
Monsanto Chemical	19.9	22.5
Union Carbide	26.5	29.6
Atlas Powder	14.8	12.8
Diamond Alkali	22.3	22.3
Hercules Powder	20.3	21.5
Hooker	24.6	27.2
Rohm & Haas	23.7	22.3
Tennessee Corp.	23.2	20.5
Average	23.4	23.7

depletion). Big increases in cash flow/share for top chemical companies over the period 1952-57 are assurance that the industry's ability to build up money reserves is better than ever.

► **Temporary Setback**—Admittedly, margins—operating and otherwise—took a clobbering in the fourth quarter of 1957 and the first quarter of this year. This befell almost all industries which reflect general business conditions as they found themselves squeezed between rapid cost upturns and sales declines.

Capacity Expansion—Critics say the chemical industry has

overexpanded in recent years. If this is so, then most industries are guilty of over-enthusiasm. Recent capital investment by chemical companies represents just about the same proportion of total industry outlay as it did in the early postwar years: 10.8% in 1957 vs. 10.3% for 1953-57 and 10.7% for 1948-52. (And bear in mind that all this time chemical output has been rising faster than all-industrial production.)

Pricing—Critics say fierce competition engendered by over-capacity is forcing chemical prices down. There has been plenty of price weakness this year—both “posted” and “under the table.” Yet wholesale chemical prices have been stronger, relative to the index for all industrial prices, than they were prior to 1957. Chemical prices have, in fact, increased in the last 12 months by a greater amount than the all-industrial products index.

Research Spending—Some industries—aircraft, electrical equipment—have a bigger research bill than does the chemical group. But no other industry spends as much of its own money (\$498 million in 1956, 97.4% of all chemical research spending).

By contrast, aircraft companies laid out only \$266 million of their own funds for research in 1956. Uncle Sam put up the rest: \$1.8 billion.

There's Plenty of Boom Left in Ammonia

The synthetic ammonia industry, on fire since World War II, is still as hot as a firecracker, according to R. P. Westerhoff, vice president of Ford, Bacon & Davis, a management and engineering consulting firm.

Eight billion pounds of new capacity will have to be built by 1975 to handle agricultural and industrial needs for ammonia, says Westerhoff. This calls for a capital layout of \$450 million at today's prices. (Existing ammonia capacity of 10 billion lb., valued at \$500 million.)

Now add in another \$50 million worth of new capacity for ammonium nitrate explosive as

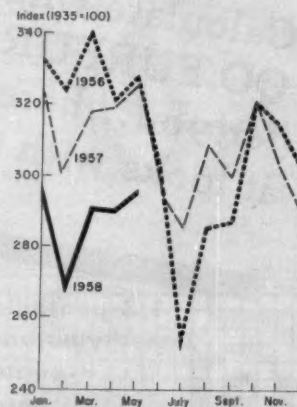
this derivative “comes into its own as a preferred material for controlled blasting.” Ammonium nitrate consumption for explosives (300,000 tons in 1956) will triple by 1975.

“Soil enrichment needs alone (now about two-thirds of present ammonia demand) could preempt existing ammonia capacity in a few short years” says Westerhoff, as farmers increase nitrogen applications. The national average was 2 lb./acre in 1940, rose to 10 lb. in the next 15 years, is expected to at least double by 1975. Most European nations far exceed this average.

Helping to back up the domestic demand for ammonia: Export of nitrogen fertilizers will increase 200% by 1975.

What with natural gas—the prime raw material—selling at 20-30¢/Mc. ft., ammonia's price outlook is very strong, too. Westerhoff claims it is possible to produce ammonia for \$30-40/ton, against today's selling price in the area of \$88.

Chemical Consumption

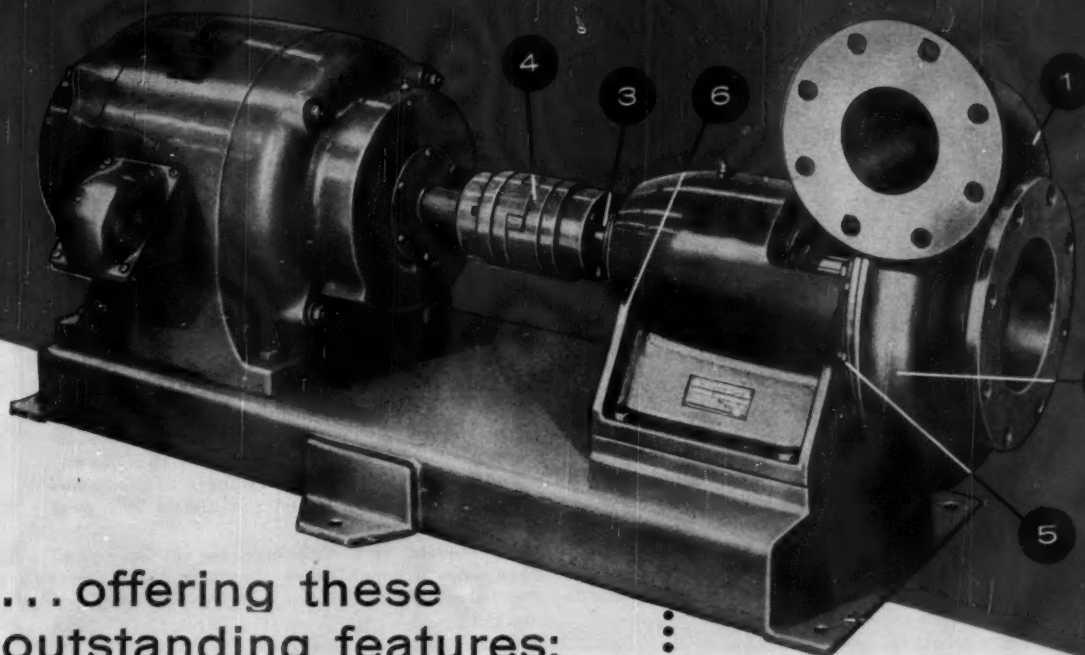


Consumption by Industries

	April (Final)	May (Est.)
Coal products	7.3	7.3
Explosives	9.2	9.5
Fertilizer	80.6	77.6
Glass	24.9	26.9
Iron & steel	10.1	11.6
Leather	3.7	3.8
Paint & varnish	33.5	36.5
Petroleum refin.	27.9	29.8
Plastics	22.3	22.5
Pulp & paper	35.5	35.4
Rayon	20.7	21.0
Rubber	5.8	5.8
Textiles	8.5	8.8
Total	290	296

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- 2 *"Francis" type impeller* . . . produces lower pressure at shaft sealing surface—minimizes danger of impeller clogging.
- 3 *Precision-machined shafts* . . . minimize possibility of deflection or vibration. Over-sized ball bearings insure long, trouble-free operation.
- 4 *Spacer type coupling* . . . allows removal of complete pump rotary assembly, including impeller and frame, without removal of base or disturbing piping or electrical connections.
- 5 *Exclusive backplate design* . . . accommodates either packing gland or mechanical seal stuffing boxes, which can be easily interchanged in the field.
- 6 *Rigid one-piece frame* . . . of cast iron, has oversized pocket for collecting any leakage from stuffing box, and can be piped to drain away from pump.

For over 35 years, Tri-Clover Division has specialized in the development and manufacture of high quality corrosion-resistant centrifugal pumps. Now, to further extend this pump line, and to meet more highly specialized pumping requirements, Tri-Clover presents an entirely new series of high efficiency centrifugal pumps.

This new series of Industrial Stainless Steel Pumps is offered in a full range of sizes and seal styles, including models to operate at temperatures of minus 80° F to plus 400° F.

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For the full story on these new pumps, write for a copy of the new Pump Bulletin 258-I.

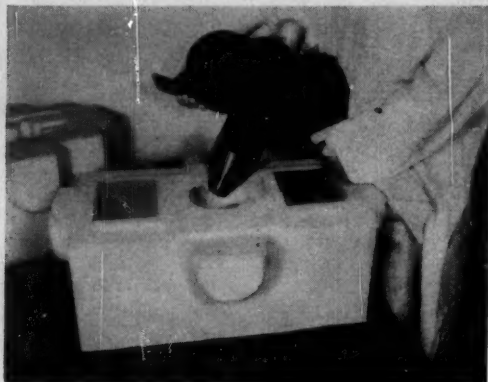
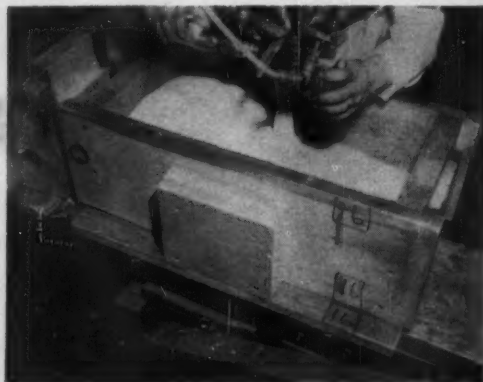


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Molded Urethane, the Precise Packing Material for Delicate Cargo

Lower in cost, weight and volume than its predecessor, molded-to-fit urethane packing now protects radar power tubes during shipping.

The urethane cushion is molded in two halves; a semi-automatic molding line turns them out at a rate of 30 halves per hour. Cavity in the cushion exactly fits the tube. The tube is totally enclosed in resilient foam.

Old package consisted of curled hair cushions and a wooden case. It weighed six times as much, had three times the volume, and cost almost 50% more than the new foam pack.

To complete the new package, the cushion will be wrapped in a paper-backed aluminum foil bag and inserted in a corrugated case.—Du Pont Co., Wilmington, Del.

76A

Protective Coating

New copolymer of butadiene and styrene for coating metals.

A new copolymer of butadiene called Polyco XP 24-97 has been developed for use in baking finishes on metal surfaces.

In the copolymerization of butadiene with styrene, the resulting copolymer still retains one double bond per unit, thus retaining a substantial degree of unsaturation. Applied to metal, the latex forms a film by the customary mechanism of fusion of the resin particles. By means of metallic catalysts and baking at elevated temperatures, cross-linking is produced and the polymer is converted from a soft, slightly tacky, solvent-susceptible material to a dry, tough, solvent-

resistant film.—Borden Chemical Co., New York, N. Y. 76B

Adhesive

For plywood, low-cost thermoset comes from tree bark.

A new bark extract, designated HT-120, is reported to be a successful intermediate agent in the formulation of a plywood bonding agent.

When it is combined with polymethylolphenol with a high proportion of reactive methylol groups, a bonding agent is formed substantially reducing the expensive phenol normally required in plywood adhesives for outdoor uses. During the hot-press operation, the reagent acts as a crosslinking and copolymerization agent for the bark extract.

The new thermosetting adhesive can be produced in a dry form or as a 40 to 45% solids solution that is stable at ordinary temperatures.—Rayonier Inc., New York, N. Y. 76C

Activated Carbon

Highly active, strong, porous catalyst support.

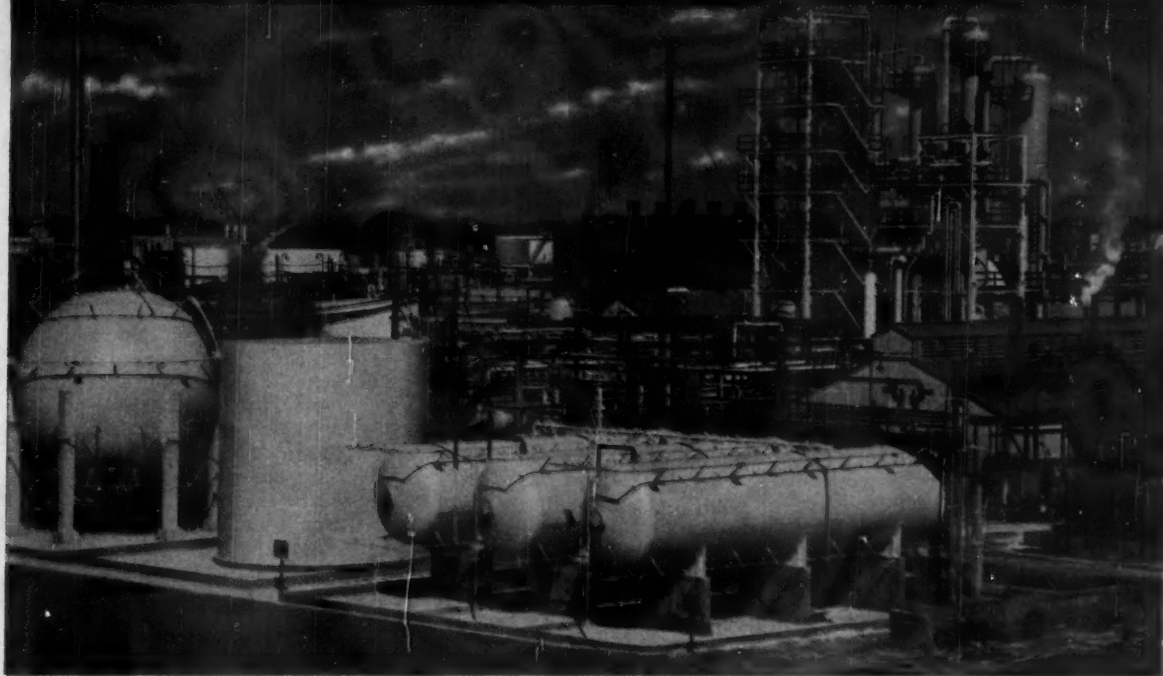
Called grade CXC 4/6, new grade of activated carbon for use as a catalyst support material is priced at half that of the company's grade CXAL 4/6 which it replaces. It is expected to give better performance than previous grades as a catalyst and in a wide variety of other uses.

Following comparative percentage figures show respective properties of the new grade vs.



Ethyl Corporation

VINYL CHLORIDE



plant engineered
and constructed by

CATALYTIC

Ethyl Corporation selected CATALYTIC for the engineering, procurement, and construction of its new Vinyl Chloride Plant. Close cooperation and coordination between Ethyl and CATALYTIC, utilizing to the fullest their joint experience with chlorinated hydrocarbons, resulted in successful on-stream operation of this plant within the scheduled completion time and budget.

CATALYTIC Construction Company



Philadelphia 2, Pennsylvania
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In Canada: Catalytic Construction
of Canada, Limited; Sarnia, Ontario;
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Catalytic On-Time... On-Budget Services

for the metallurgical, chemical, petrochemical and oil refining industries:
Project Analysis; Process Development;
Process Design; Economic Studies; Engineering; Procurement; Construction.

standard grades: carbon tetrachloride activity (indication of carbon performance as an adsorbant)—70 vs. 55-65; hardness (measure of resistance to breakdown in service)—98.9 vs. 85-95 min.; ash (purity, the absence of materials that might poison the catalyst metal or contaminate the process stream)—0.5 vs. 3-8; water pickup (useful pore volume)—89.5 vs. 60-70.

Manufactured from a specially-selected petroleum derivative, the new grade is in the form of 3/16-in. dia. pellets for uniform impregnation and easy reactor charging. — **National Carbon Co., New York, N. Y. 76D**

Fire Extinguishers

New top fighter of Mg or Ti fires, a liquid.

Callery Chemical takes aim at more than one jet-age market with boron compounds produced at its Lawrence, Kans., plant, in operation as of last month. Along with high energy fuels, trimethoxyboroxine, first liquid—as opposed to harder-to-apply solids—effective against light metal fires is made.

► **Navy's Choice** — Already judged by the Navy to be the most efficient extinguishing agent available for increasingly frequent magnesium fires in aircraft fire situations, it has been standard equipment these past ten months on naval air station crash trucks. It is also currently the only agent entirely satisfactory for titanium fires.

Though other firms are selling commercial grades of trimethoxyboroxine, Callery has patents on its use as a metal fire extinguishing agent (No. 2,787,329), describes its grade as a "colorless liquid containing a high percentage of trimethoxyboroxine," trademarks it TMB.

Chemically, trimethoxyboroxine is $(\text{CH}_3\text{O})_3\text{B}_2\text{O}_3$. Its boric oxide content is 60%. TMB's function in this application is actually that of a carrier for boric oxide. When applied to a fire, TMB quickly decomposes and its principal product of combustion, boric oxide, forms

a molten coating which effectively excludes the atmosphere from metal fires.

► **Solid Competition** — The few other commercially available effective fire extinguisher materials for light metal fires are solids. G-1, developed around 1941 by Dow for magnesium fires, is now a product of the Pyrene Div. It is a crude graphite powder mixed with a high-boiling organic phosphorous compound. As a powder, G-1 has underwriters approval to be dispensed only via scoop or shovel. It is effective for magnesium fires but for titanium fires must be piled on to an uneconomical degree.

Met-L-X, developed by Ansul Chemical Co. around 1950 and now produced and sold by that company, is sodium chloride to which is added materials to make it free-flowing and moisture repellant and a thermoplastic resin that won't support combustion. Because it's a free-flowing, very fluid powder, it can be dispensed through hose or piping just as well as liquid. It's designed chiefly for magnesium and liquid metal (sodium, potassium) fires, is not good for titanium fires. When applied, it adheres and coats burning material. Consequently, large amounts of material are not required for effectiveness.

Neither Met-L-X or G-1 is useful for lithium fires. For that, Ansul has developed ELFEA (Experimental Lithium Fire Extinguishing Agent) which it markets in very limited quantities. ELFEA is a graphite fluid powder, but different from G-1.—**Ansul Chemical Co., Marinette, Wis. 78A**

TMB and all of the solid extinguishers mentioned above are being tested on zirconium fires but as yet there are no conclusive results. TMB is not suitable for lithium or liquid metal fires, shows about equal promise as others for zirconium fires.

A key consideration in TMB use is price. A TMB extinguisher re-charge runs around \$60 as compared to a Met-L-X re-charge at roughly \$7.50. For this reason and the fact that the speedy control available

with TMB is not so vital in usual industrial situations, TMB has not been used for industrial magnesium fires. Met-L-X has been effective enough. TMB's market is where it can do a significantly better job, e.g. crash fires or Ti fires.—**Callery Chemical Co., Pittsburgh, Pa. 78B**

BRIEFS

Polyamide resin, Versamid 140, has been developed to improve performance of Versamid-epoxy combinations. Key properties of the resin are low viscosity, long pot life, high heat distortion point.—**General Mills, Minneapolis, Minn. 78C**

New quaternized ethoxylated amines, trade marked Ethoquads, are water soluble, cationic surface active agents with properties combining those of quaternary ammonium chlorides and ethoxylated fatty amines. They differ from quaternary ammonium compounds in type of groups attached to the nitrogen.—**Armour & Co., Chicago. 78D**

Zirconium hydride is available in two new grades: for the nuclear industry (MHI grade R) and for general commercial application (grade C). Grade R contains less than 0.01% Hf.—**Metal Hydrides Inc., Beverly, Mass. 78E**

New resinous products for reinforced plastic applications combine the ease of handling of polyesters, high temperature resistance approaching phenolics and desired electrical characteristics for applications such as radomes.—**General Electric Co., Pittsfield, Mass. 78F**

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 199)

You're looking at the exclusive key to continuous dust collecting!

You are inside a Pangborn Dust Collector. And this is Pangborn's traveling manifold . . . the exclusive self-cleaning development that permits continuous suction at highest efficiency. The result is the incomparable performance of cloth type collectors with minimum resistance to air flow and with no shutdown required.

Typical Pangborn engineering . . .

This advance is particularly important in collecting finely-divided dry dusts. But the Pangborn engineering it typifies is important to *any* dust-producing plant. It is not enough to place a dust collector within a plant. An efficient dust collecting system must be *scientifically* planned, designed and constructed to handle effectively a specific dust problem. This *thinking* is incorporated into every Pangborn proposal.

. . . that can help you

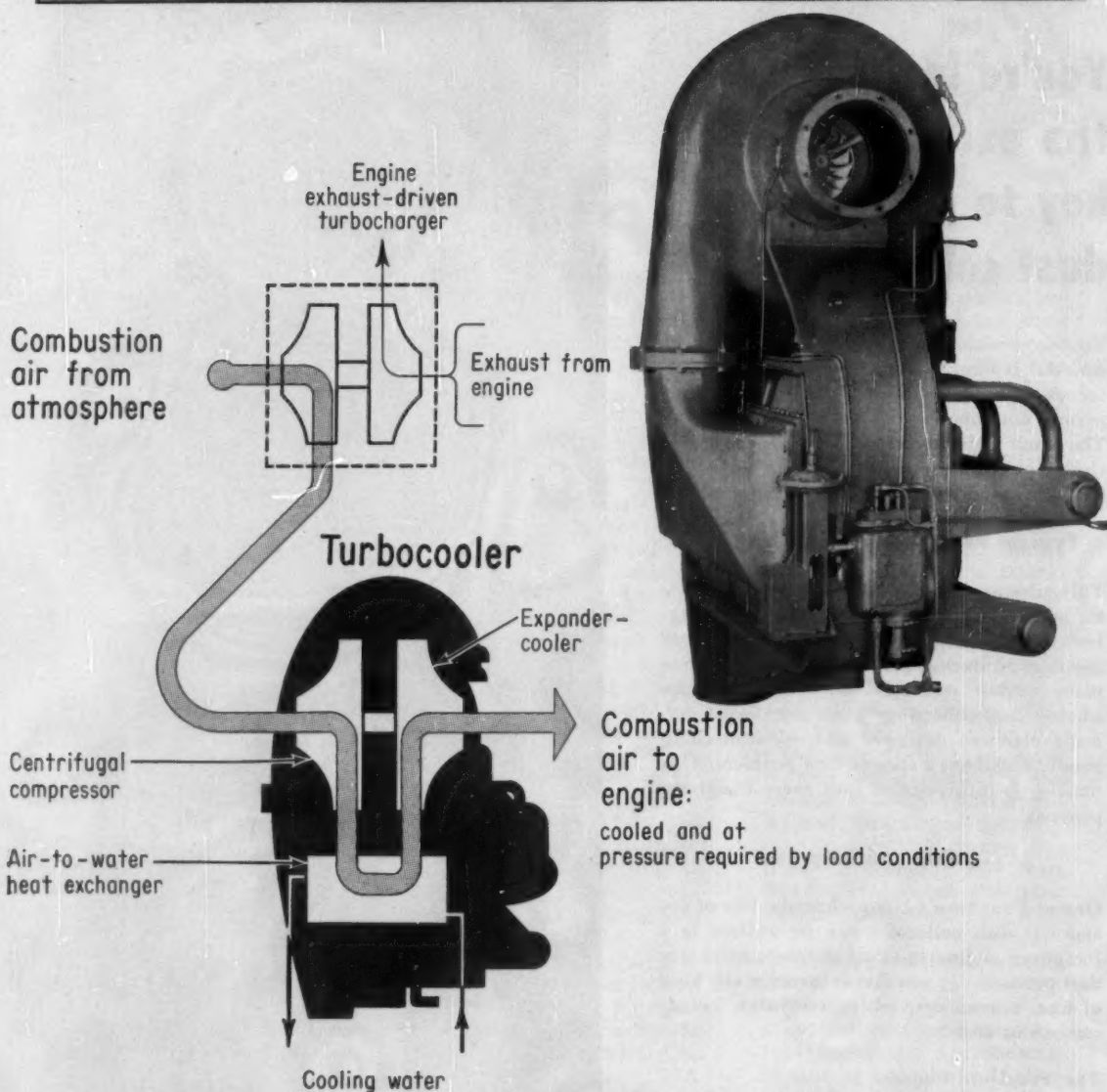
One of Pangborn's comprehensive line of dry and wet dust collectors can be utilized in a Pangborn-engineered dust system to solve *your* dust problem . . . whether it involves any kind of fine, coarse, dry, moist, corrosive, hot or obnoxious dusts.

The Pangborn engineer in your area will be glad to take off his jacket and go to work for you. He is a dust *expert* and will discuss your individual problem at no obligation. And, for more information, write for "Out of the Realm of Dust" to: PANGBORN CORP., 2600 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control and Blast Cleaning Equipment.*



Pangborn

CONTROLS **DUST**



Air Turbocooler Ups Gas-Engine Performance

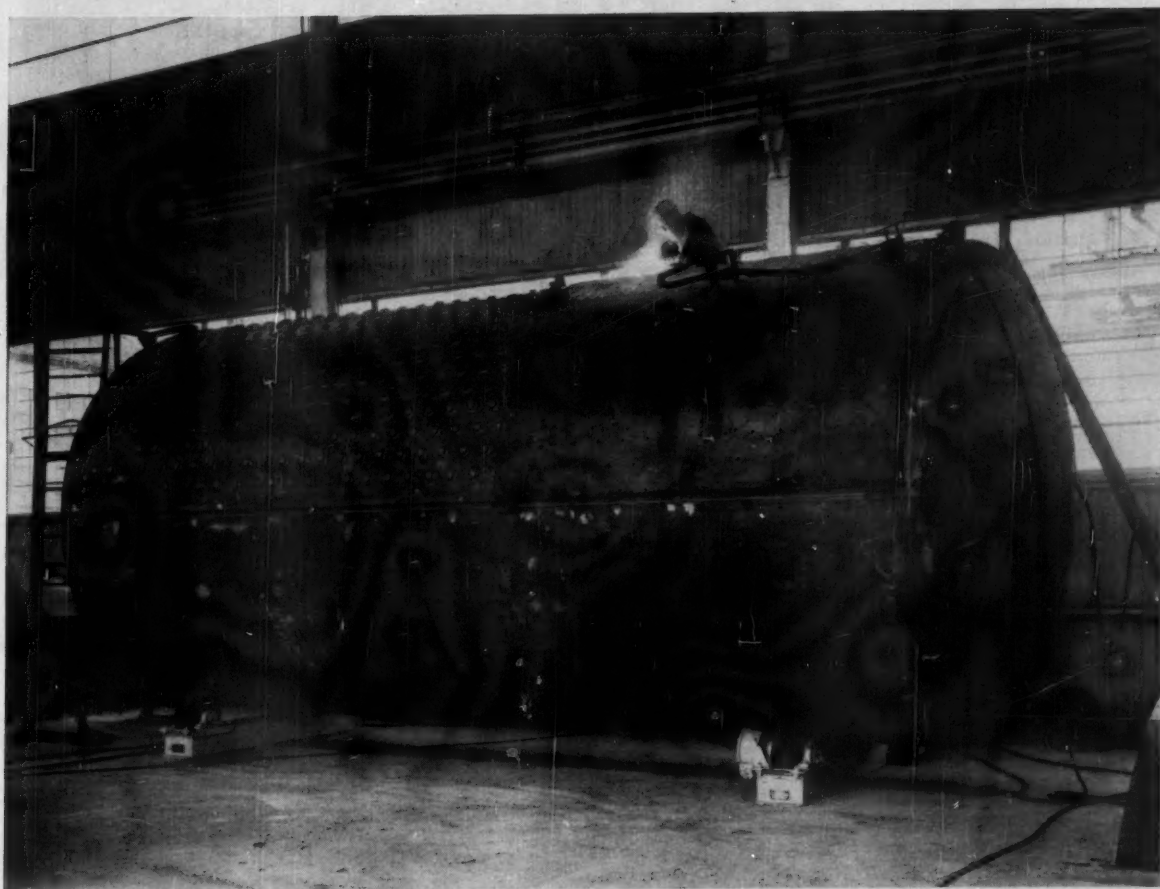
A near case of "lifting oneself by the bootstraps," this combustion air conditioner enables gas engines to pull extra horsepower with less fuel.

Turbocooling is a promising way of getting more for your money. Dollars invested in high-compression, turbocharged gas

or gas-diesel engines work harder when an engine is turbo-cooled—you save on fuel costs, and get more horsepower.

According to the Cooper-Bessemer Corp., maker of turbocoolers, actual field experience has proved that turbocooled engines grind out up to 23% more power, and use up to 5% less fuel. The first turbocoolers were put in service back in January, 1955. And now, over 150 units are in successful operation.

MTB Fabrication Fact Sheet



Hot Solution To A Storage Problem

A chemical manufacturer had a problem.

A liquid chemical had to be stored while awaiting truck and tank car pickup. Also, at normal temperatures it was impossible to keep the chemical from "salting out".

They needed a storage tank which would eliminate this problem. Missouri Boiler provided the answer in this 12'0" O.D. x 28'0" long Jacketed Tank. This vessel was designed for an external pressure of 125 p.s.i. @ 350°F. To solve the "salting out" problem the

bottom 120° was steam jacketed using 788 stays welded to the tank and plug welded to the jacket. These stays were used to stiffen the shell to withstand the external pressure. The completed vessel was installed and the problem was solved.

Missouri Boiler has the experience and skill to custom fabricate to your needs. May we suggest that you add us to your bidder's list for steel and alloy plate fabrication from 1/4" to 1 1/4". We think you'll be pleased with our better prices and dependable deliveries.



MISSOURI BOILER AND TANK COMPANY

Formerly Missouri Boiler and Sheet Iron Works

2218 Papin Street

St. Louis, Missouri

Some of these were sent out as original equipment on new engines. Others are factory-built kits that were field-installed on existing equipment.

Briefly, the turbocooler is a bootstrap device consisting of three basic parts—centrifugal compressor, heat exchanger and expander-cooler. Compressor and expander are on same shaft.

Combustion air from the engine's turbocharger, boosted in pressure by the turbocooler's compressor and cooled by its exchanger, throttles through the turbine-type expander, thus driving the centrifugal compressor. The net effect of these manipulations is a combustion air that's substantially cooler than ambient air.

► Here Are Principal Benefits—

The cooler the combustion air, the more that can be crammed into an engine. With more air in the cylinders, fuel intake can be greater, and combustion more efficient. As a result, turbocooling leads ultimately to increased load-pulling ability, smoother combustion and greater fuel economy.

Load-pulling ability does not vary exactly inversely with temperature. However, in the normal combustion-air temperature range of Cooper-Bessemer's engines, this ability does increase at a rate of about 1.5 bmep. (brake mean effective pressure, psig.) per deg. F. of temperature drop. Other makes of engines probably benefit about as much.

Smoother combustion results from improved flame propagation attributable to the lower combustion-air temperatures. Resulting detonation-free operation provides lower cycle peak pressures, with inherently reduced mechanical and thermal loading; also, engine operation becomes noticeably quieter.

Cooper-Bessemer tests also showed that fuel economies improve at a minimum rate of 4.0 Btu./bhp.-hr. per deg. F. of temperature drop. Some of the engines tested showed an air-temperature sensitivity of as high as 10 Btu./bhp.-hr., °F.).

► Compression Before Cooling

—In operation, filtered combustion air at elevated temperature and pressure discharges from

the engine's turbocharger and enters directly into the centrifugal compressor section of the turbocooler. Here, the air undergoes a second stage of compression, and leaves at a temperature and pressure level considerably higher than that when it entered the turbocooler. The air next passes through the air-to-water heat exchanger, where it loses heat. Cooled, high-pressure air then flows into the expander-cooler section of the turbocooler.

Since the air's pressure at this point is always much higher than the intake-manifold pressure required for any specific engine load, expansion to the required manifold pressure does work in the centrifugal-compressor-loaded expansion turbine. As a result, air temperature drops, sometimes as much as 40 F.

The principle behind this effective means of combustion air conditioning is that air leaving the turbocooler's compression stage, by virtue of its extra-high temperature, transfers much more heat to the cooling water than would have been possible with a temperature reached after only a stage of normal turbocharging followed by normal aftercooling.

► Availability — According to the manufacturer, turbocoolers improve the operation of any high-compression turbocharged gas engine, and are available in all sizes. For instance, Cooper-Bessemer rates some of their turbocooled gas engines as high as 166 bmep. Turbocoolers are not applicable to atmospheric gas engines.—The Cooper-Bessemer Corp., Mount Vernon, Ohio. 80A

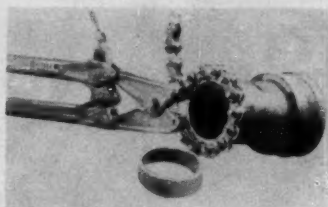
Oscilloscope

Provides visual check on flow, temperature.

An a.c. bar-graph oscilloscope, which displays up to 40 separate signals simultaneously, permits continuous visual monitoring of multichannel data from thermocouples, flowmeters and piezoelectric pressure gages. Determination of the temperature profile of cracking

units or distillation columns is a typical application.

Designated as Model AC-40BG, the unit presents its display as a vertical bar graph, 9 in. high by 12 in. wide. Height of each bar is a linear function of input signal. An overlay provides vertical and horizontal reference lines. — Industrial Products Div., IT&T Corp., Lodi, N. J. 82A



Pipe Cutter

New tool cuts quickly, cleanly, accurately.

Designed for cutting Duriron, tile, transite and soil pipe, a new one-man pipe cutter requires no vise or turning. Just wrap the chain around the pipe and pull the handle—the job is done. According to the manufacturer, the unit cuts cleanly and without breakage in a fraction of a minute.

Ideal for close quarters, the cutter handles pipe sizes from 2 to 4 in. as is, or up to 15 in. by addition of extra chain.—Wheeler Mfg. Co., Ashtabula, Ohio. 82B

Control Panel

Tested control centers shipped ready for hook-up.

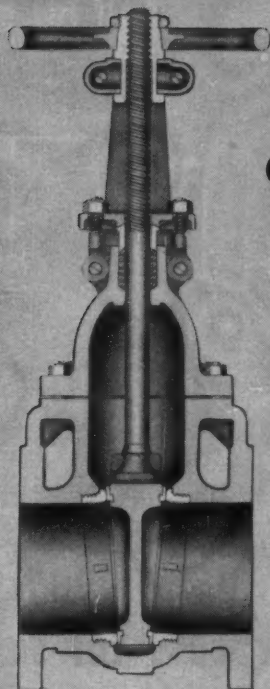
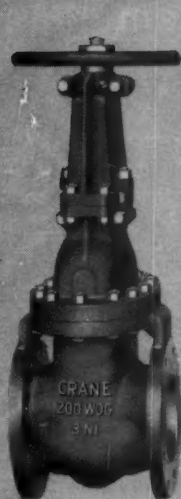
Produced to customer specifications, factory-assembled process control centers receive thorough factory testing under simulated conditions prior to shipment. The free-standing panels, designed for maximum ease of maintenance, are available in two expansible modular sizes: 36 in. wide by 84 in. high, and 48 x 84 in.

Made of heavy-gage steel, the

These significant equipment developments are continued on page 168.

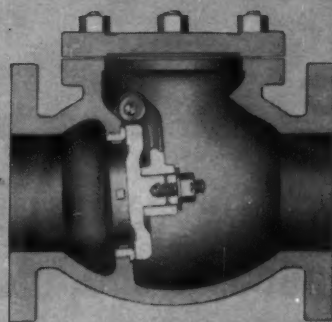
NEW CRANE VALVES FOR PROCESS INDUSTRIES

3% NICKEL ALLOY CAST IRON



Gates and Swing Checks

18-8 SMO (Type 316) Alloy Trimmed



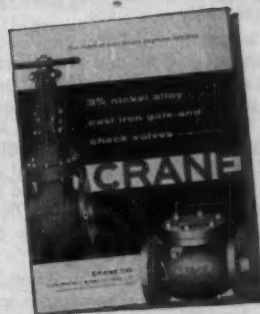
11 SIZES — 2 TO 18 INCHES

Better Corrosion Resistance... Longer Life... on More Fluids

This metal—Crane 3% nickel alloy iron—was developed especially to extend the usefulness and economy of cast iron valves in the process industries.

At but slightly higher cost, Crane 3% nickel iron valves provide substantially better resistance to corrosion than ordinary cast iron, and they have notably higher physical properties. Efficiency is stepped up further with Crane 18-8 SMO (Type 316) stainless steel trim.

Typical Recommended Applications: You will save with these valves—in the petroleum industry, for example—on oils containing traces of mineral acids; in wood-treating processes—on creosote vapors and oils; in pulp and paper mills—on alkaline liquors of various kinds. In general, they should be considered where all-iron or brass-trimmed iron valves are subject to seat corrosion.



ASK FOR THIS CIRCULAR

Complete technical and specification data on these valves are given in Circular AD-2313. Ask your Crane Representative for a copy, or write to address below.

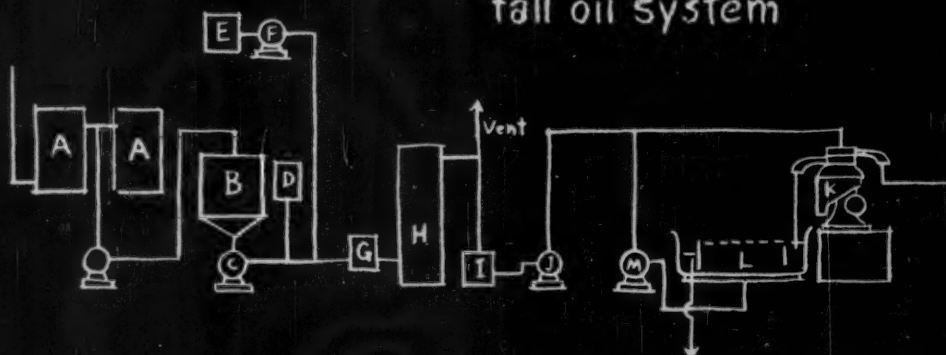
CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas

CHEMICAL ENGINEERING—September 8, 1958

Flow chart of De Laval continuous tall oil system



Paragraph 3 below is a detailed explanation of this flow chart

"De Laval developed the first simple and practical continuous acidulation process for tall oil production."

Fred Wheelwright, De Laval Separator Company

De Laval's engineering staff developed their first continuous centrifugal process for producing tall oil from black liquor skimmings in 1955. The first commercial application was installed (at Rayonier) in the spring of 1956 and has been operating successfully ever since.

How it works: In the illustration above, I am standing in front of a flow chart of the De Laval continuous centrifugal process. A proportioned amount of diluted sulfuric acid is continuously reacted with the soap skimmings from settled black liquor. Entrained gases are removed and the mixture is continuously separated into tall oil and concentrated salt cake liquor in the De Laval AC-VO nozzle-type centrifuge.

Explanation of the flow chart: Skimmings from the black liquor skimmers are gravity settled in several large soap storage tanks (A). The settled soap, with as much black liquor removed as is practical by settling, is pumped to a soap feed tank (B). From the feed tank, it is continuously pumped to processing by a variable speed, positive displacement pump (C). Hot water (D) is added to reduce soap viscosity. Dilute sulfuric acid (E) is added by a variable speed proportioning pump (F), and the acidified mixture immediately enters a high-speed mixer (G) where the soap and acid are thoroughly mixed and then passed on to a paddle-type reac-

tor (H) where the reaction is completed.

The reacted mixture flows to a gas release tank (I) where entrained gases are released. If not released, the entrained gases would seriously hamper separating efficiency. The de-gassed mixture is pumped (J) to a De Laval AC-VO nozzle-type centrifuge (K) where the tall oil is continuously separated from the reaction mixture. Salt liquor discharge from the centrifuge flows to a collecting tank (L) to remove lignin and to recycle some of the clear acid salts in solution through the recycle pump (M). Recycling acts as a flushing medium to help remove lignin from the centrifuge and balances out the feed to the centrifuge.

Further refinements: The system, developed in 1955, is still the basis of continuous tall oil processing. But we found that many plants have a possible additional saving. Where the sulfuric acid-chlorine dioxide pulp bleaching process is used in a pulp mill, the waste sulfuric acid from the process is an ideal (and money-saving) material for acidulating the black liquor skimmings. The innovation created some strong corrosion control problems at first, but further development eliminated the vibrating screen used on earlier tall oil systems (chief sufferer from corrosion). Enlargement of the nozzles enabled the centrifuge to pass all fibers in the solids discharge phase.

Improved and simplified, this system operates 24 hours a day, 5 days a week in a mill operation with no centrifugal plugging and no costly screen maintenance. The tall oil produced is the same high quality as from conventional plants, and cheaper since it eliminates the necessity of purchasing additional sulfuric acid. De Laval has also developed a complete water wash system for use in tall oil fractionating plants which are now processing batch acidulated crude.

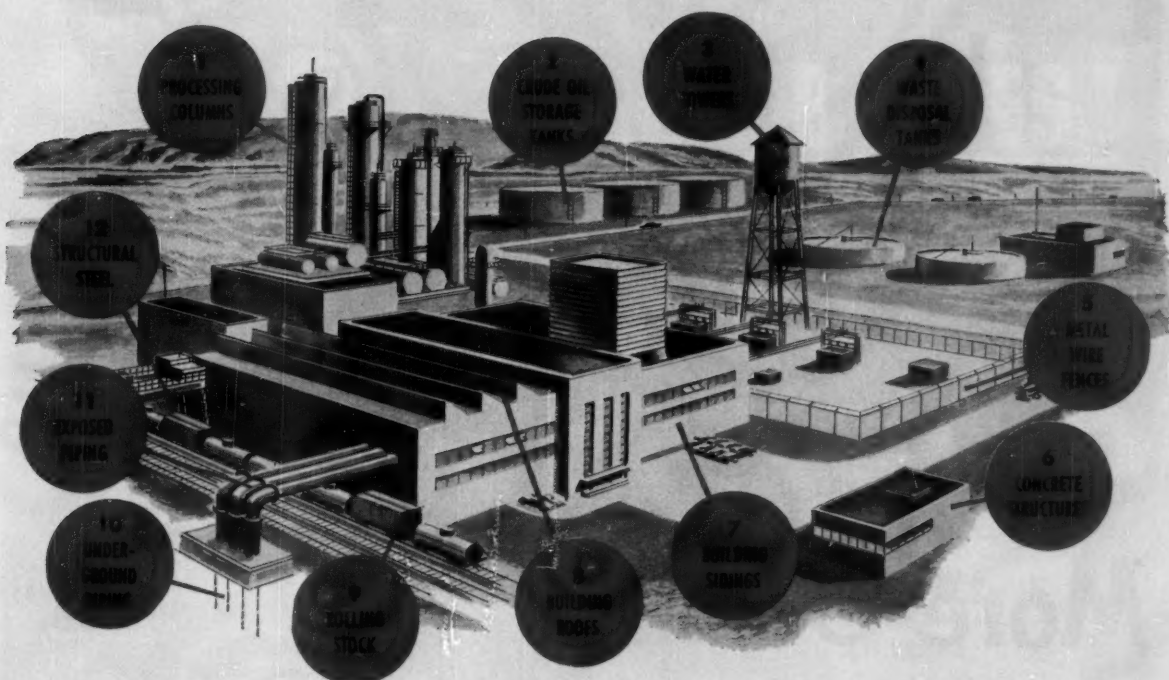
In all types of processing: De Laval engineers have cooperated with industry in many other instances to find a better and cheaper way of producing a quality product. Whatever your process, whatever its present limitations, why not talk the problems over with a De Laval Sales Engineer? Or write direct: we welcome your inquiries for this particular process or any other. Just drop us a line on your letterhead.



THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
Chicago, Illinois

DE LAVAL PACIFIC COMPANY,
201 E. Millbrae Avenue, Millbrae, Calif.

Solve Your Plant's Toughest Corrosion Problems with these PITT CHEM Coatings



1. Processing Columns—For corrosion control alone, use *Insul-Mastic 4010* gilsonite-asphalt vaporseal. For insulation and corrosion protection, use *Insul-Mastic 553* Type D with incorporated cork granules.

2. Crude Oil Storage Tanks—For bottom and top of interiors, use patented *PITT CHEM Tarsel* coal tar-epoxy resin coating. For exterior use *Insul-Mastic 4010*, *553* or *PITT CHEM 101* coal tar coating.

3. Water Towers—For interior, use tasteless, odorless *PITT CHEM 104* coal tar coating. For exterior, use *Insul-Mastic 4010*.

4. Waste Disposal Tanks—Use acid and alkali-resisting *Tarsel* or tough, heavy-bodied *PITT CHEM 101*.

5. Metal Wire Fences—Apply weather-resisting *PITT CHEM 102* coal tar coating with roller or brush.

6. Concrete Structures—Use *Insul-Mastic 4010* vaporseal or *Mica-Mastic 5402*, a synthetic resin coating containing white mica, specifically compounded for waterproofing and decorating masonry.

7. Building Sidings—Weatherproof with *Insul-Mastic 4010* and finish with *Insul-Mastic Color Coat*. Available in eight shades, *Color Coat* is specifically designed for use over *PITT CHEM* coal tar and *Insul-Mastic* coatings.

8. Building Roofs—Use *Insul-Mastic* roofing coatings outside. For condensation control and insulation on underside, use *Insul-Mastic 553*.

9. Rolling Stock—Apply *Insul-Mastic Dednox* coatings for protection of frames, box car ends and roofs of railroad cars.

10. Underground Piping—Use *PITT CHEM Tarsel* or *PITT CHEM 101* heavy duty coal tar coating.

11. Exposed Piping—Protect with *Tarsel* or *Insul-Mastic 4010* and code with *Insul-Mastic Color Coat*.

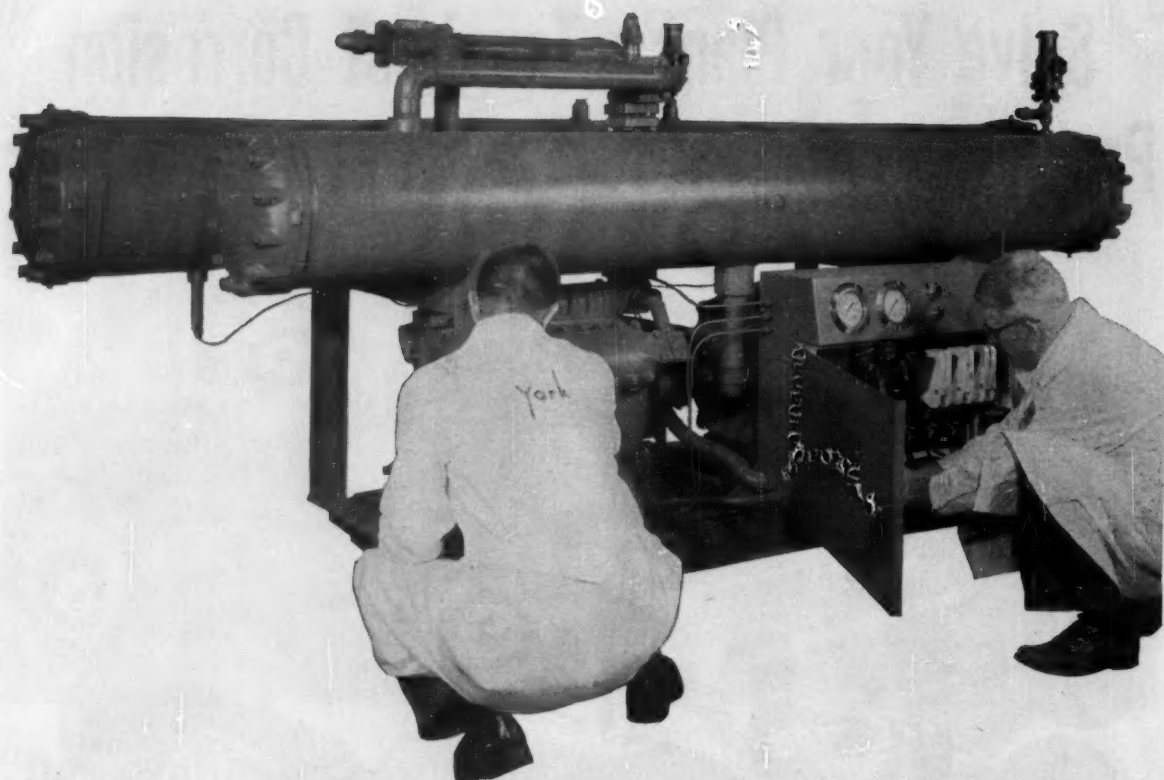
12. Structural Steel—Apply economical, weather-sealing *Insul-Mastic 4010*.

THERE'S hardly a corrosion problem around your plant that can't be controlled with a *PITT CHEM* coal tar or *INSUL-MASTIC* gilsonite-asphalt coating. From ordinary weatherproofing to stopping tough chemical and underground corrosion, there's a *PITT CHEM* coating to do the job efficiently and economically.

Pitt Chem Industrial Coatings are available through leading Industrial Distributors. See the "Yellow Pages" of your telephone directory.



PROTECTIVE COATINGS • COAL CHEMICALS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON



More Cooling

**IN 20% LESS FLOOR SPACE WITH
YORK PACKAGED WATER CHILLER!**

**Compact, Factory-Assembled Unit Installs Anywhere
In The Building—Without Costly Installation!**

York Packaged Water Chillers offer consultants, architects and building managers the first practical answer to the critical space/cost problems in air conditioning new buildings. Each complete, factory-assembled package features integrated arrangement of all components—with built-in assurances of substantially reduced operating and maintenance costs!

Exclusive Flooded Coolers and positive refrigerant feed control mean top efficiency over the entire range of load conditions. Automatic capacity controls save power by

continuously adjusting output to prevailing load conditions. Exclusive capillary oil return assures uninterrupted oil flow under light loads! All this, in a line that has the broadest range of capacities in the industry—from 18 to 250 tons! All this, in whisper-quiet, vibration-free, lightweight units that require no special foundations or space-consuming structural supports!

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SUBSIDIARY OF BORG-WARNER CORPORATION
IN CANADA—SHIPLEY COMPANY OF CANADA, LIMITED

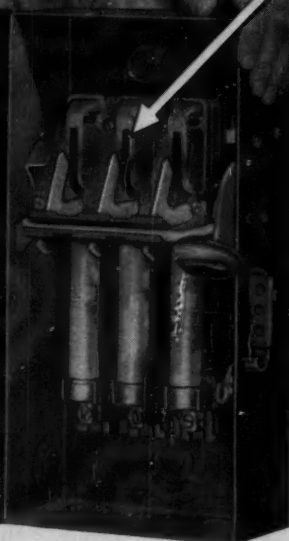


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the quality name in air conditioning**

Manufacturers of Residential and Commercial Heating and Cooling Systems • Air Conditioning and Refrigeration Equipment for Industrial and Commercial Installations • Room Air Conditioners • Ice Makers • Refrigeration Units and Systems



IF YOU WANT COMPLETE SAFETY
IN YOUR SAFETY SWITCHES—
REMEMBER THE "V" FOR
VISIBLE BLADES!



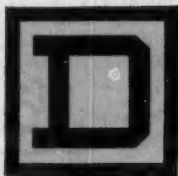
HERE IS ANOTHER
REASON WHY
SQUARE D
HAS HELD FIRST PLACE
FOR MORE THAN
50 YEARS

**Positive Pressure
(SPRING LOADED)
Fuse Clips**

- ✓ Maintain positive contact as fuses alternately heat and cool. Fuses are held tight even where vibration is present or during short circuit surges.
- ✓ Fuse clip jaws use pure copper for current-carrying parts and spring steel for pressure. They reduce heating 80% over commercial type clip.
- ✓ No clamps or screws to tighten—or to forget to tighten.

The men who pull the switches will tell you what can happen when a switch, *believed* to be open — *isn't*. A lot of things can happen—and every one of them is bad. Personnel safety is in jeopardy. Motors can single-phase. Machinery and work can be damaged. Down-time can skyrocket.

Doesn't it make sense to insist on **Visible Blade** construction which gives you a road block against any of those possibilities? Doesn't it make equally good sense to insist on the safety switch which gives you that construction—plus a lot of other performance advantages?



EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY



sure it's big

... but not particularly big or unusual

in Carlson's production of stainless steel plate

IT was normal, but not easy, for Carlson specialists to handle this big plate. Type 304-L stainless, it measured $\frac{3}{16}$ " x $131\frac{1}{2}$ " x $452\frac{3}{16}$ " and weighed an impressive 7923 pounds. And when this big one landed at the customer's receiving dock it was *exactly* what he wanted... *right* by chemical composition, *right* by physical standards, *right* to specification and *right* to size.

Whatever you need in stainless steel—big plates, small rings, formed or cut-to-shape items—will be

produced accurately and on time. Stainless steel is our *only* business, and we know it. That is why you can depend on Carlson to give you *what you want when you want it!* Your inquiry is invited.

G.O. CARLSON Inc.

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PLATES • PLATE PRODUCTS • HEADS • RINGS • CIRCLES • FLANGES • FORGINGS • BARS AND SHEETS (No. 1 Finish)

Maintenance and Steam Traps

... there's a relationship that goes far beyond trap maintenance alone

Good traps and good trapping have a greater effect on your maintenance costs than does trap maintenance itself. By that we mean that the right traps, properly selected and installed, and with the benefits of a preventive maintenance program, will save far more maintenance dollars than they will cost.

Under the pressure of spiralling maintenance costs, this thought becomes mighty important. Let's take a look at what it involves:

Proper Selection of Steam Traps

1. Be sure it's the right type of trap.
2. Be sure it's sized right and is for the correct operating pressure.
3. Be sure it's first rate in design and construction.

Proper Installation of Steam Traps

1. Install them so they are accessible for inspection and maintenance.
2. Install a test valve.
3. Use a union or unions.
4. Use a shutoff valve or valves.
5. Use a strainer ahead of the trap if dirt conditions are bad.
6. Use a by-pass only where continuity of service is imperative.
7. Standardize inlet and outlet connections.

Preventive Maintenance Program

1. Test trap regularly for proper operation. (Trap size, operating pressure and importance determine frequency.)

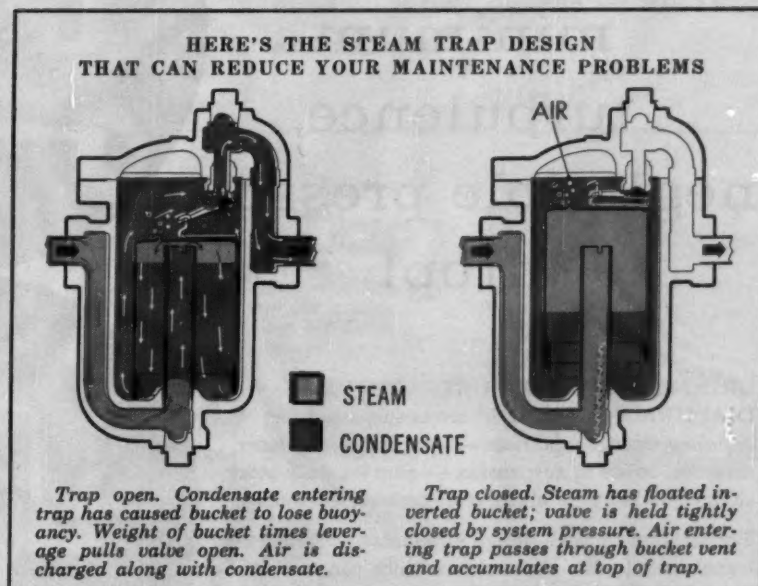
2. Inspect internal mechanism at least once a year.

You Get Indirect Benefits As Well

The direct benefits of the plan outlined are pretty obvious — good traps, properly selected, require less maintenance... testing and inspection prevents troubles that lead to maintenance.

However, this plan provides indirect benefits which reduce maintenance in other parts of the plant as well:

Good traps save steam and reduce the load (and consequently maintenance) on fuel handling and



burning equipment and on ash handling equipment.

Good traps protect the system by eliminating water hammer and preventing the damage it can do.

Good traps discharge carbon dioxide before it can go into solution to form corrosive carbonic acid — less corrosion, less maintenance.

Good traps increase production to reduce the length of time equipment must operate or reduce the amount of equipment needed... either way maintenance is reduced.

How to Go About It (The Sales Pitch)

We admit we're prejudiced, but we don't think there is any better way to select steam traps than with the help of the 44 page Armstrong Steam Trap Book. Here in a single source is specific data on the selection and sizing of traps, how to install them for best results, and how to maintain them most economically.

The Steam Trap Book will also give you full information on the design and construction of Armstrong Inverted Bucket Steam Traps that offer these important maintenance-reducing advantages:

1. Armstrong Traps are dependable.

2. Armstrong Traps require no adjustments — go from full load to zero load automatically.

3. Armstrong Traps are self-scrubbing—ordinary dirt conditions can't hurt them.

4. Armstrong Traps have long-life parts — valve and seat are heat treated chrome steel — lever assembly and bucket are stainless steel.

5. Armstrong Traps have water sealed valves to minimize wire drawing and erosion.

Ask for your copy of the Steam Trap Book—there is no obligation. Then test Armstrong Trapping. If you are not completely satisfied with the results, you can return the traps for a full refund of the purchase price. You can't lose much that way. Call your local Armstrong Representative or Distributor, or write

Armstrong Machine Works
8585 Maple Street
Three Rivers, Michigan



**ARMSTRONG
STEAM TRAPS**

Maximum flow,
minimum
turbulence,
negligible pressure
drop!

GRINNELL-SAUNDERS STRAIGHTWAY DIAPHRAGM VALVES* are unsurpassed for handling viscous materials — semifluid foods, latex, magmas; solids in suspension — slurries, pulp stock, sludges; fluid-borne abrasives; corrosive chemicals.

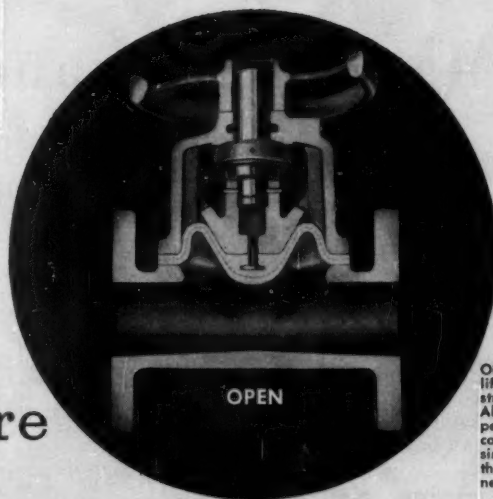
The straight-through design eliminates pockets, gate trenches and other obstructions which can trap solids. The result is maximum flow, minimum turbulence, and negligible pressure drop for a diaphragm valve.

The straight-through design also has the advantage of causing very little basic change in the direction of the fluid stream, thus reducing abrasive action from high velocity particles.

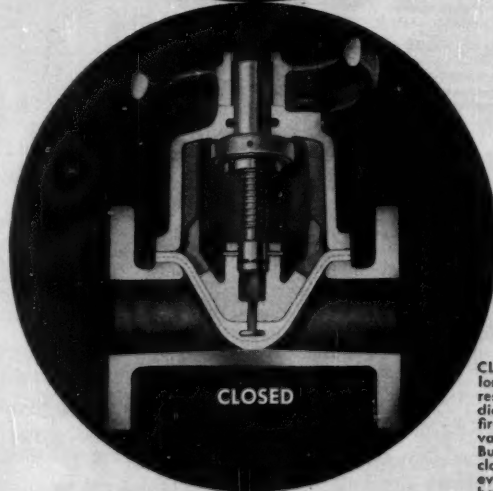
These advantages are in addition, of course, to benefits normally associated with the use of diaphragm valves . . . such as freedom from corrosion and clogging of working parts, since these are completely sealed off by the diaphragm; prevention of product contamination; elimination of stem leakage and routine maintenance, because there are no packing glands. Also, when properly pitched, lines are self-draining.

Grinnell-Saunders Straightway Diaphragm Valves are available in a choice of body sizes and materials, linings and diaphragms. Handwheel or power operated. For complete information, write Grinnell Company, Inc., 277 West Exchange St., Prov. 1, R. I.

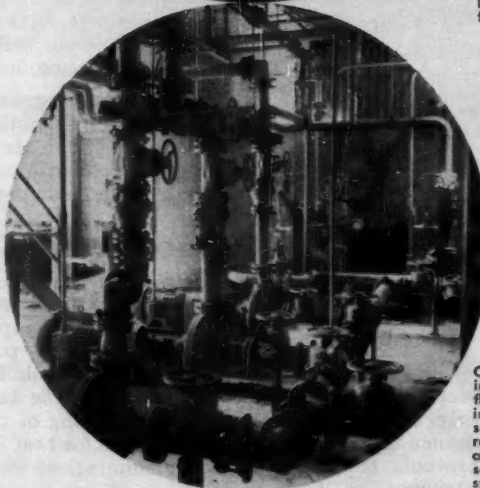
*Patented



OPEN Diaphragm lifts high for streamline flow. Also, valve design permits comparatively simple rodding through, when necessary.



CLOSED Despite long usage, resilient diaphragm seals firmly against valve body. Bubble-tight closure is assured, even when handling gritty or fibrous materials.



Clogging and interruption to flow is prevented in lines handling a suspension of rubber particles in an acid brine solution at this synthetic rubber plant.

GRINNELL-SAUNDERS DIAPHRAGM VALVES

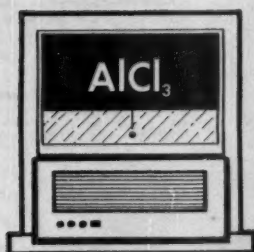
Grinnell Company, Inc., Providence, Rhode Island

Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

BRIEFS

on a way you might save money on caustic soda... why we air-condition aluminum chloride... three hypophosphites... a new bulletin on Hooker chemicals



Why we air-condition aluminum chloride

Ever notice how aluminum chloride lumps up in humid or rainy weather?

It's because this is a thirsty chemical, drinking water right out of the air. Trouble is that it loses a lot of its value as a catalyst and reactant when it's wet.

There was a time when we didn't even try to make aluminum chloride on humid days.

But now we've put air-conditioning in, and we can make it all year 'round—assuring you a uniform, full-strength product, come rain or come shine.

You can get it in any of these four sizes:

1. Extra fine—90% to 95% through 40 mesh.
2. Fine unscreened—almost all through 20 mesh.
3. Coarse unscreened—through 1 mesh, 25% to 35% through 20 mesh.
4. Coarse screened—through 1 mesh, on 20 mesh.

For technical data, just check coupon.

Did you know you can get three different hypophosphites?

You get your choice of calcium, potassium, and sodium when you order Oldbury® hypophosphites.

All three are N.F. Grade materials with the sodium salt also in a commercial grade, and are available in any quantity you need. They are all white crystalline compounds with no odor.

Calcium hypophosphite forms soluble salts and presents a good means of holding phosphorus in solution. It's typically 99% $\text{Ca}(\text{H}_2\text{PO}_2)_2$.

Potassium hypophosphite assays 99% KH_2PO_2 .

Sodium hypophosphite is a strong reducing agent and antioxidant. The N.F. Grade assays 98% Min. $\text{NaH}_2\text{PO}_2 \cdot \text{H}_2\text{O}$. The Commercial Grade assays 84% Min. NaH_2PO_2 . (Equivalent

Maybe you can save money on liquid caustic soda

If, like most of us, you're tightening budget belts this year, this nomograph ought to be of interest to you.

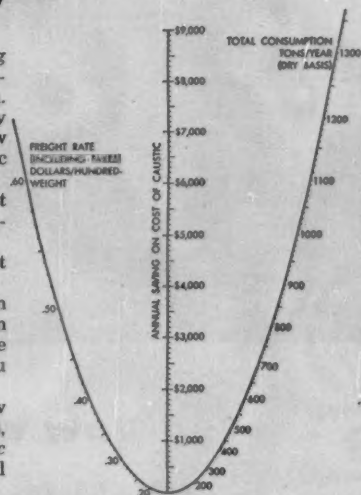
It can help you find out quickly if any substantial savings will follow a switch from 50% liquid caustic soda to 73%.

Draw a line from your current freight rate to your estimated annual consumption.

Any savings will show at the point where you cross the center line.

Of course, you'll have to figure in an annual depreciation on dilution equipment. We'll be glad to advise you on what you need, and how you might save money here, too.

For more facts like these on how to pare your caustic soda costs, check the coupon for our *Caustic Soda Buyer's Guide*. Better yet, call the nearest Hooker Sales office.



to 101% $\text{NaH}_2\text{PO}_2 \cdot \text{H}_2\text{O}$).

For more information on any or all of these compounds, send the coupon.

New bulletin lists chemicals, useful data

To bring our fast-growing list of chemicals up-to-date, we've prepared a new General Products List.

Its 12 pages give you a quick refer-

ence guide to all our chemicals and services.

With each product is a condensed listing of important specifications along with information on shipping containers.

For a copy, just check the coupon for Bulletin 100-B.



For more information, check here and mail with your name, title, company and address.

- | | |
|--|--|
| <input type="checkbox"/> Caustic Soda Buyer's Guide | <input type="checkbox"/> Potassium Hypophosphite, N.F. |
| <input type="checkbox"/> Aluminum Chloride | <input type="checkbox"/> Sodium Hypophosphite, N.F. |
| <input type="checkbox"/> Calcium Hypophosphite, N.F. | <input type="checkbox"/> Sodium Hypophosphite, Comm. |
| <input type="checkbox"/> General Products List | <input type="checkbox"/> Bulletin 100-B |

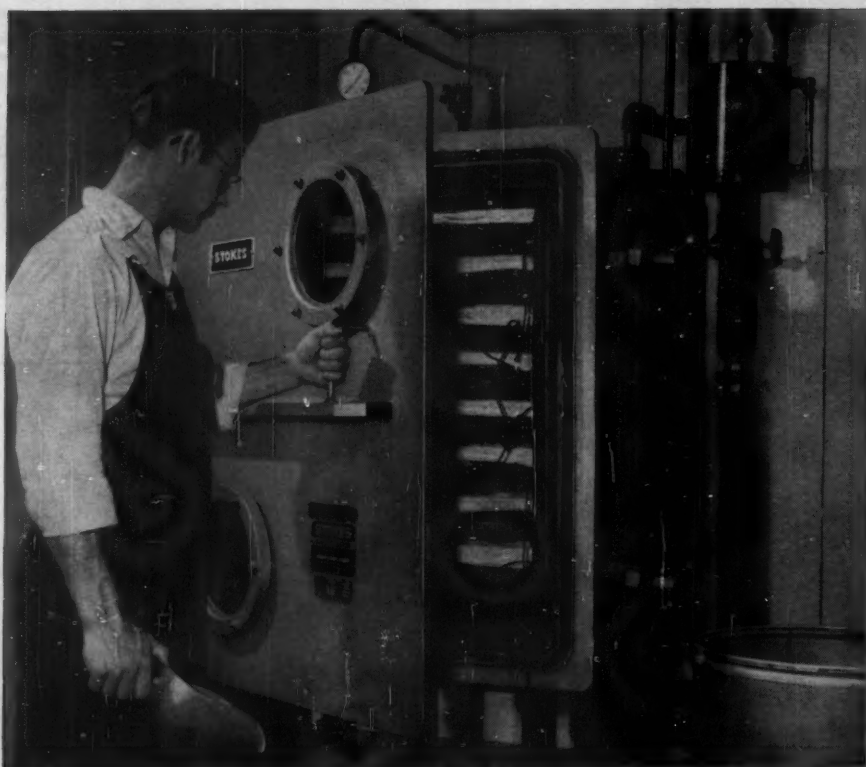
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409 FORTY-SEVENTH STREET, NIAGARA FALLS, N. Y.

Sales Offices: Chicago Los Angeles New York Niagara Falls
Philadelphia Tacoma Worcester, Mass.

In Canada: Hooker Chemicals Limited, Neith Vancouver, B. C.

HOOKEr
CHEMICALS
PLASTICS



An operator in the Saran Process Laboratory of the Midland Division of The Dow Chemical Company loads material into a Stokes Vacuum Shelf Dryer. This unit is equipped with nine, 24" x 36" drying shelves . . . and provides 3" free clearance between shelves.

Dow chooses Stokes Vacuum Shelf Dryer for Saran Laboratory

The new Saran Process Laboratory of the Midland Division, The Dow Chemical Company (Midland, Michigan), has installed a Stokes Model 238-F Vacuum Shelf Dryer. This equipment is being used for drying a variety of resinous products on a laboratory and developmental scale. This particular model was furnished as a complete package, including a Stokes 9KW electrically heated hot water system with temperature range of 80 to 210° F.

Stokes Vacuum Shelf Dryers enable the safe drying of heat or air-sensitive materials which must remain dormant during processing. Units are available for heating by hot water, steam or heat transfer liquids.

Fabrication is from ASME Code-inspected materials — by ASME Code-certificated welders — with final inspection according to ASME Code. All manifold connections are made outside the chamber, eliminating any risk of product contamination by internal leakage. Major components for a variety of shelf drying systems are stocked — for fast delivery, while meeting individual customer requirements.

Stokes produces rotary vacuum dryers, rotating vacuum dryers, vacuum shelf dryers, drum dryers and flakers, tabletting equipment . . . maintains a complete laboratory to provide expert application assistance. Write Stokes, or contact your nearest Stokes office for complete information.

Vacuum Equipment Division
F. J. STOKES CORPORATION
5500 Tabor Road, Philadelphia 20, Pa.

STOKES



A large diameter steel head takes form on one of Claymont's spinning machines—units that turn out heads up to 19 feet in diameter, in ferrous and non-ferrous metals. Integrated facilities make Claymont a reliable source of quality steel plate and plate products for industry.

by d'Araizien

CLAYMONT SPUN HEADS



CHECK CLAYMONT FOR—Alloy Steel Plates • Carbon Steel Plates • Stainless-Clad Steel Plates
High Strength Low Alloy Steel Plates • CF&I Lector-Clad Nickel Plated Steel Plates • Pressed
and Spun Steel Heads • Manhole Fittings and Covers • Fabricated Steel Products
Large Diameter Welded Steel Pipe

PRODUCTS OF WICKWIRE SPENCER STEEL DIVISION • THE COLORADO FUEL AND IRON CORPORATION
Plant at Claymont, Delaware • Sales Offices in all Key Cities

5745

Foxboro introduces

**ELECTRONIC
CONSOTROL*
INSTRUMENTATION**

On September 15th, at the I.S.A. Show in Philadelphia, The Foxboro Company will unveil Electronic Consotrol Instrumentation...counterpart of its world-famous pneumatic Consotrol line. *✓ ✓ ✓* Including a complete range of transmitters, indicators, recorders, controllers and valve operators, Electronic Consotrol Instrumentation covers every function in the control loop...provides advanced-design electronic control systems for all modern requirements. *✓ ✓ ✓* In these systems, process measurements such as temperature, pressure, flow and level, are converted to a proportional current signal at the transmitter. Long-distance transmission is instantaneous...over unshielded lines...to small-case, Consotrol panel-type receivers at the central control station. *✓ ✓ ✓* The full story on this major Foxboro contribution to better process control will be presented in Booth No. 12-72 at the I.S.A. Show. Or, write for comprehensive Bulletin 21-10. The Foxboro Company, 369 Neponset Avenue, Foxboro, Mass.

*Reg. U.S. Pat. Off.

FOXBORO
REG. U.S. PAT. OFF

*Foxboro makes a better instrument...
or Foxboro doesn't make it*

WE wouldn't be in business, if YOU couldn't

cut costs with these unusual refractories!

Take advantage of the one *good* thing to come out of the recession: EXTRA TIME . . . time to look around . . . time to spot areas where better materials will give you better service—and help cut your operating costs.

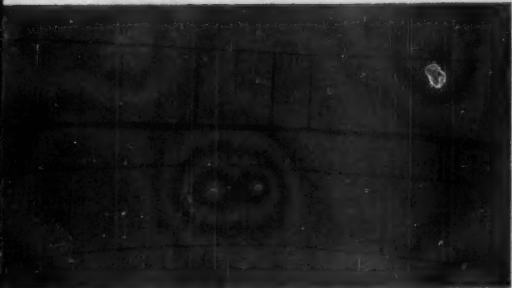
For instance: Those "vulnerable" areas in your furnace—i.e. areas subjected to flame impingement or heavy loads, or exposed to abrasion or corrosion. Or other "working" areas where heat must pass *through* the refractory. In these spots, you may profit handsomely by substituting one of our special-purpose refractory materials. Materials designed *specifically* to meet these conditions.

A **For example:** One customer replaced hard-burned, acid-proof brick in the vertical wall area of a cyclone dust collector with our CARBOFRAX® silicon carbide lining. After three years' service, the CARBOFRAX lining still shows practically no wear. Whereas before, the lining was badly cut out after only a few *weeks*. Quite a saving! . . . in materials, in labor, in downtime.

B **For example:** In another furnace, 300-lb. annealing baskets and 50-lb. motor heads were pushed directly over a fireclay hearth. But maintenance costs were so high that a CARBOFRAX hearth was substituted. This not only solved the maintenance problem, but also transmitted the heat rapidly—and made possible a *saving of one third in fuel*.

C **For example:** The sidewall, backwall and main arch of an oil-fired furnace were replaced with Carborundum's super refractories because the operator was getting only three months life. After the changeover, life increased 300%!

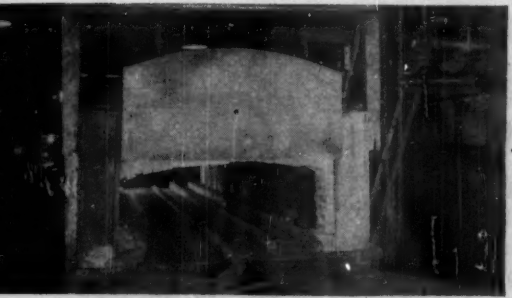
Granted, Carborundum's refractories cost more. But they also *save* much more—in terms of refractory life . . . furnace downtime . . . and maintenance costs. They also *do* more—in terms of higher furnace output . . . faster heat transfer . . . and increased efficiency. In short, *we* wouldn't be in business if *you* couldn't cut costs with super refractories.



A Nothing resists abrasion like an abrasive, such as silicon carbide. Here, for example, is a CARBOFRAX lining that outlasted hard-fired brick on the order of 3 years to 6 months. That's why so many operators are using CARBOFRAX linings in dust collectors, downcomers, coke chutes, and similar equipment exposed to severe wear.



B Pictured here is the oil-fired furnace mentioned in the copy. It's used for working 450-lb. drill bits. The dull bits are heated in the right-hand opening to 2000 F, then dressed and returned to the left opening for tempering at 1450 F. At the time of this photo, our refractories had been used for well over 3000 hours—were still in good condition.



C The three parts of this furnace that take the most abuse are each made of CARBORUNDUM's super refractories. The hearth and skid rails are silicon carbide. The piers are our electric furnace mullite—still going strong after five years. The skids, when pictured, had been in service three years with no replacement necessary.

Here's how you can start cutting costs:

It will take less than an hour to read these two booklets about the applications — and properties — of Carborundum's unique, new super refractories. Send for them today.

Subscription to "Refractories"

is yours for the asking. This technical brochure is published approximately every other month; contains a wealth of information on new refractory materials, lining techniques, etc. Offer limited, so write soon.

Refractories Division, The Carborundum Company,
Perth Amboy, N. J., Dept. H-98.

CARBORUNDUM

Registered Trade Mark



SPROUT-WALDRON

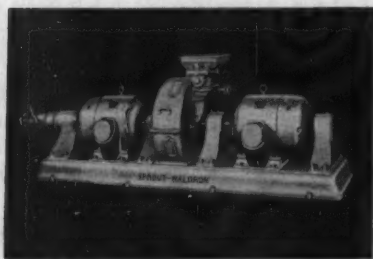
Pointers

for Mixing and Blending • Size Reduction
Size Classification • Bulk Materials Handling • Pelletizing and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

PACKAGE ASSEMBLY FOR RECLAIMING LEATHER SCRAP HAS MANY OTHER USES

A complete package assembly originally developed for defiberizing leather scrap has been adapted to the reclaiming of other waste materials. The Sprout-Waldron package consists of a rotary knife cutter, a single disc defiberizing mill, a double disc attrition mill, two beaters for separating the nibs, and the necessary products collect-



Typical Sprout-Waldron double runner attrition mill used in leather scrap reclaiming system.

ing system for handling the end product.

Feature of the system is the use of two attrition mills. The pre-cut leather scrap is partially opened by the spiketooth action of the single disc mill. It is then rubbed out into a smooth fiber by the fine style T plates of the double disc mill.

Sprout-Waldron attrition mills have been *Adaptioneered*® for a variety of purposes. These include such things as the recovery of cord and rubber from scrap tires, the production of fine wood flour, the powdering of mica, the pulverizing of coconut and other nut shells, the shredding of rags, granulating of plastics and dozens of other uses. Bulletins 133 and 143 give the facts.

LIVE BOTTOM BINS INCREASE PROCESS EFFICIENCY

Greater production, a more uniform product and smooth process flow have been achieved at Corn Products Refining Company through the use of S-W live bottom bins. Previous to the installation of these bins there were extensive variations in the rate of feed fed to the dryers.

The bins are designed so that the corn fiber contacting the rotating screws at the bottom keeps flowing in a uniform stream regardless of the level in the bin. This changes a batch operation into a continuous process.

Three bins are used. The large one handles coarse corn fiber at 21 lbs. per cu. ft. It has a capacity of 1400 cu. ft. and is designed to deliver from 12,000 to 48,000 lbs. per hour. The second bin, used for fine fiber which weighs 25 lbs. per cu. ft., has a capacity of 400



Typical base section of large S-W live Bottom Bin, with five parallel screws, designed to assure uniform feeding of many different granular, fibrous and powdered materials.

cu. ft. and will deliver from 7,000 to 28,000 lbs. per hour. Bins for gluten have a capacity of 200 cu. ft. and are designed to deliver between 10,000 and 40,000 lbs. per hour. Since the installation of Sprout-Waldron live bottom bins the variations in filter press output which previously caused dips and surges in the process stream no longer affect the feed to the dryers. The result—increased process efficiency and lower production cost.

— SW —

Glue Manufacturer Cuts Mixing Time From 3 Hours to 15 Minutes

The use of an *Adaptioneered*® S-W Vertical Batch Mixer not only reduced mixing time from 3 hours to 15 minutes, but cut mixing and packaging costs in half and saved 125 feet of floor space while achieving perfect batch uniformity in blending ground dry glue.

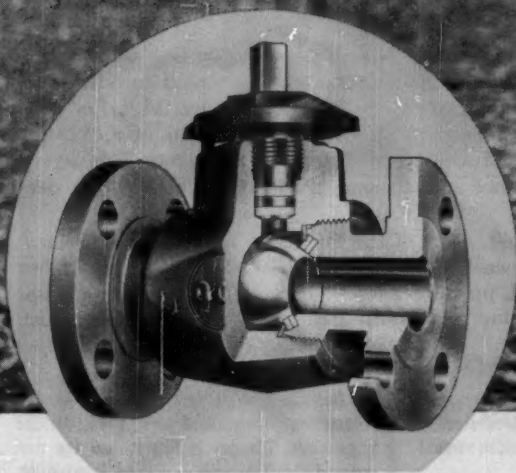
For any reasonably free-flowing type of material, this mixer offers tremendous advantages. In this in-

stallation, the 300 cubic foot mixer requires only 50 square feet of floor space although its capacity is equal to 12,500 pounds per batch. Power requirements are 20 HP, and the mixer is completely self-cleaning and dust tight.

Get the full-story on Vertical Mixing by reading Bulletin 192. Copies on request.

CP/107

**"There are no bugs
in this new product"**



Says Maintenance Foreman of large gas processing plant.

W-K-M's new QCF[®] non-lubricated BALL VALVE

**This new product of
W-K-M's *Creative Engineering*
has been service-proved
with these ladings.**

Acetate • Crude ammonia liquor • Aviation fuel and Stoddard solvent • Propane • Toluol • Methylenehtketone (MEK) • Alkaline slurry • Jet engine fuel (test cells) • Naphtha and coal tar solvents • Paint cleaner and thinner • Liquid soaps, DDT and chlordane • Vinyl chloride • Butadiene liquid • Copper ammonium acetate • Carbon bisulphide • Cleaning naphtha • Lime and soda ash slurry • Riboflavin media • Gasoline (tank truck) • Helium gas • Coke oven by-product gas • Gasoline (tank car) • Chlorinated solvents.

For 3½ years, users tested this new valve in the hardest services that could be found.

Now, W-K-M offers it to you as a **service-proved** new product, a new product with no bugs, a typical example of W-K-M's leadership in design, production and service.

This valve will deliver promised performance; you can specify it with complete confidence in its efficiency, economy, ease of operation and maintenance.

You should know more about it.

Write for Catalog 1000 for complete information.

AVAILABLE in carbon steel (ASA 150 lb., 300 lb.), and semi-steel (200 lb. WOG, 400 lb. WOG); sizes range from ½" through 6". Also ASA 600 lb., sizes ½, ¾ and 1".

W-K-M

**DIVISION OF QCF INDUSTRIES
INCORPORATED**
P. O. BOX 2117, HOUSTON, TEXAS

If you use filter systems...

CHECK THESE MULTIPLE ADVANTAGES

OF THE REVOLUTIONARY **JET-CLEANED**

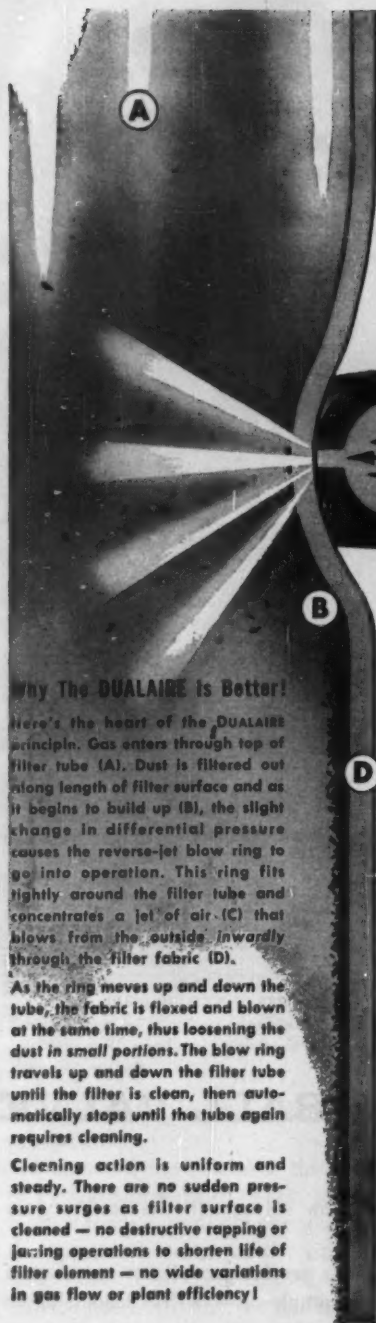
Dualaire*

DUST COLLECTOR!

No pressure surges!

No filter choking!

Efficiencies up to 99.99%!



Why The DUALAIRE is Better!

Here's the heart of the DUALAIRE principle. Gas enters through top of filter tube (A). Dust is filtered out along length of filter surface and as it begins to build up (B), the slight change in differential pressure causes the reverse-jet blow ring to go into operation. This ring fits tightly around the filter tube and concentrates a jet of air (C) that blows from the outside inwardly through the filter fabric (D).

As the ring moves up and down the tube, the fabric is flexed and blown at the same time, thus loosening the dust in small portions. The blow ring travels up and down the filter tube until the filter is clean, then automatically stops until the tube again requires cleaning.

Cleaning action is uniform and steady. There are no sudden pressure surges as filter surface is cleaned — no destructive rapping or jarring operations to shorten life of filter element — no wide variations in gas flow or plant efficiency!

There are many other advantages built into the DUALAIRE. For further details send for descriptive 8 page booklet. Or contact your nearest Western Precipitation representative!

If you use bag-houses or other similar collecting systems in your plant operations, be sure to investigate the many vital advantages built into Western Precipitation's new DUALAIRE Dust Collectors. Backed by the same well-known organization that pioneered commercial application of COTTRELL Electrical Precipitators and MULTICLONE Mechanical Collectors, DUALAIRES bring entirely new performance and efficiency standards to filter-type collection systems.

As outlined at the left, heart of the DUALAIRE is a jet-cleaning blow ring that travels up and down the cloth filter tube, keeping it clean without the alternate choking and pressure surges characteristic of conventional rapping, vibrating, or jarring systems of cleaning off the collected dust.

Result—

► **UNIFORMLY LOW PRESSURE DROP** is assured, because the collected dust is removed steadily and in small increments — not by sudden surges!

► **UNIFORMLY HIGH EFFICIENCIES** — as high as 99.99% under actual field conditions — are maintained by the constantly-cleaned filter surfaces. There is no "choking" action — no variation in filter capacity as dust accumulates!

► **LONGER FILTER LIFE** is obtained because the filter fabric is not subjected to destructive jarring, rapping and vibration of conventional filter cleaning methods. The Dualaire cleaning action is gentle — yet far more effective!

► **LESS EQUIPMENT IS REQUIRED** to handle a given capacity with the Dualaire because no standby sections need be provided for gas cleaning while other sections are shut off for rapping.

The Dualaire filter is kept constantly clean — automatically — while it is filtering out the suspensions. The gas is filtered and the dust removed simultaneously — without interruption. Saves space, simplifies installation!

► **MAXIMUM ADAPTABILITY** to varying installation requirements is assured by the "sectionalized" design of the Dualaire. Each section is available in 5 different heights — and as many sections can be bolted together as desired to meet plant requirements. As needs increase, simply add more sections!

► **EFFICIENT STRAIGHT-THRU DESIGN** of filter tubes assures easier dust recovery, better flow. Dirty gas enters top of tube, is filtered through the walls, and dust drops by gravity through bottom of tube into collection chamber. Separated material does not re-entrain in the gas flow



WESTERN

PRECIPITATION

CORPORATION

Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

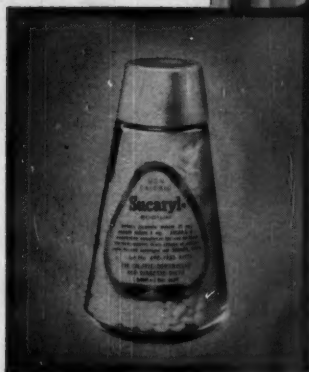
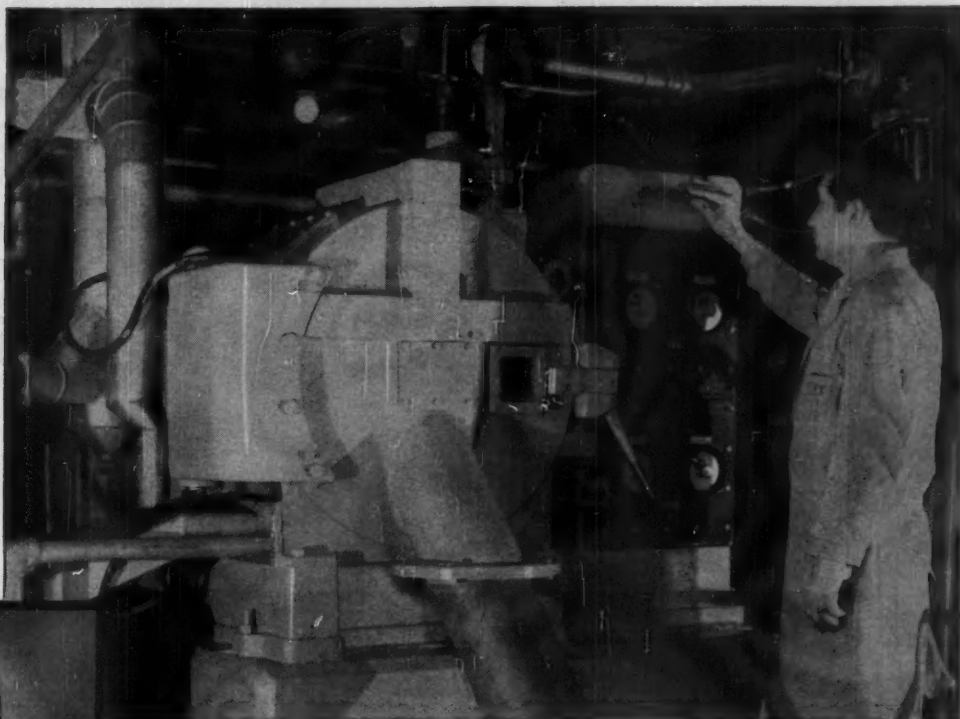
LOS ANGELES 54 • NEW YORK 17 • CHICAGO 2 • PITTSBURGH 22 • ATLANTA 5 • SAN FRANCISCO 4

Representatives in all principal cities

Precipitation Company of Canada Ltd., 8285 Mountain Views Avenue, Montreal 9



COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
TURBULAIRE-DOYLE Scrubbers
HOLO-FLITE Processors
HI-TURBIDANT Heaters



ABBOTT LABORATORIES finds BAKER PERKINS HS Universal Filtering Centrifugal cuts costs and maintains high product quality of SUCARYL

Since installing a Baker Perkins Centrifugal, Abbott Laboratories of North Chicago, Ill., has been able to triple its separation rate in the production of Sucaryl, its popular non-caloric sweetener. The B-P Type HS-20W Centrifugal now gets the same production in 8 hours that required 24 hours in the two center-slung centrifugals that it replaced. Since the centrifuge is totally enclosed, a high product quality has been realized. Operating on a 3 minute cycle, it produces a uniform moisture content crystal (18-20 per cent moisture) from a slurry containing 60 per cent solids. This uniform moisture is considered

very important in the subsequent drying operation. As in the case of Abbott Laboratories, Baker Perkins centrifugals mean unsurpassed efficiency and economy . . . B-P centrifugals are built in a wide range of sizes and types, so whatever your needs may be, there's a B-P unit to do the job. Why not have a B-P Sales Engineer recommend the proper size and type centrifugal for your application.

See our Insert in Chemical
Engineering Catalog for
additional information.



BAKER PERKINS INC.

**CHEMICAL MACHINERY DIVISION
SAGINAW, MICHIGAN**

339



Tailor-made,
tough and
chemically
inert...

... these J-M Chempac Teflon components
combat chemical and solvent action!*

SMALL OR LARGE . . . intricate or simple . . . J-M Chempac® Teflon components have proved their exceptional resistance to the constant attack of corrosive chemicals in rugged service.

Look to J-M for Teflon packings, gaskets, and moulded shapes made to your exact specifications . . . or for parts that are machined to close dimensional tolerances. Moreover, we can combine Teflon with top quality J-M asbestos to impart the exceptional sealing and heat-resistance properties of the "magic mineral." And in addition to corrosion-resistance, Teflon gives you the advantages of an extremely low coefficient of friction . . . toughness and flexibility . . . and weight-saving possibilities.

You can also obtain J-M Chempac Teflon Packings in moulded and

braided types for pumps and valves . . . in a wide range of flange and envelope-type gaskets . . . in rings, cups, sheets and tapes. Your J-M Packings Distributor can supply your needs. Or write Johns-Manville, Box 14, New York 16, New York. In Canada: Port Credit, Ontario.

*TM for DuPont Tetrafluorethylene resin.

Teflon rods, tubes, tapes and sheets—in addition to components of varied sizes and shapes as indicated here—are also available from Johns-Manville. Prompt delivery of any quantity you need is assured by new J-M production facilities.



JOHNS-MANVILLE

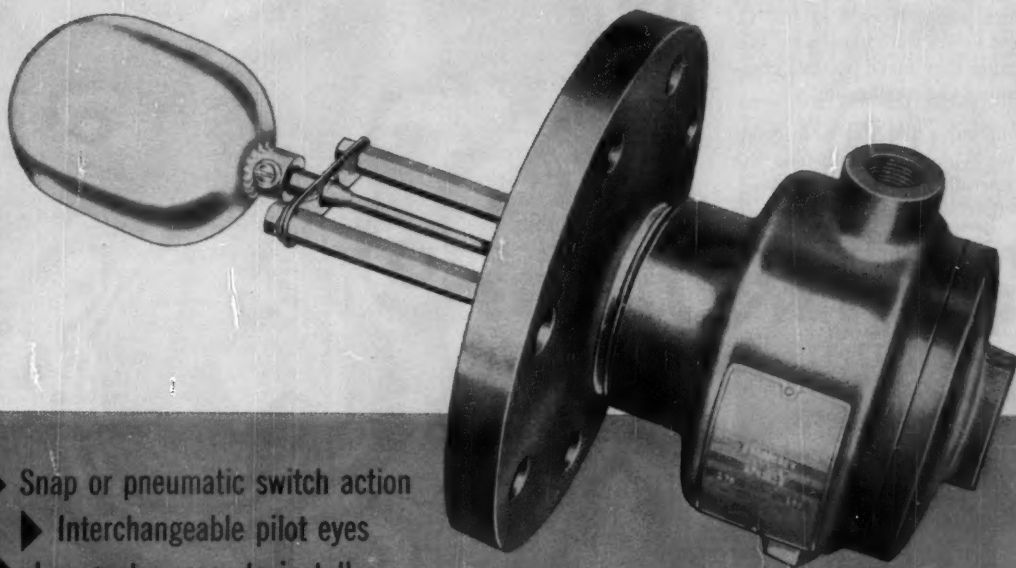
100 YEARS OF QUALITY PRODUCTS . . . 1858-1958



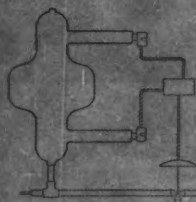


Series 2800—The oil man's Level Controller for Lease Automation

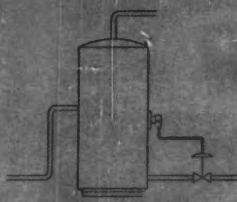
FISHER



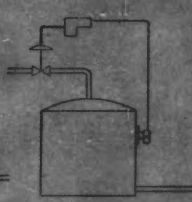
- ▶ Snap or pneumatic switch action
- ▶ Interchangeable pilot eyes
- ▶ Low cost... easy to install



Type 2806-252V controlling level of volumetric measurement vessels for accurate control of liquid volume.



Separator or line scrubber control



High level shut-in control in tank farms

252V HOUSING ASSEMBLY

Sizes—4" iron or steel, flanged, with ratings up to 900 p.s.i. Available with coupling type, welding type or screwed bar housing. Float size 3 1/2" x 6" stainless steel. Pressures up to 1000 p.s.i. Solid plastic available for pressures over 1000 p.s.i. Flexure tube—K Monel.

PILOT ASSEMBLIES

Type 2800—Explosion-proof electric switch assembly—snapping range—1/2"—1" with 1.0 specific gravity liquid. Electrical rating—20 amp., 125, 250, 440 volt AC. Color coded wiring.

Type 2806—Pneumatic relay with snapping range of 1/2" to 1 1/4", with 20 p.s.i. air supply.

Type 2807—Pneumatic relay for throttling service. Available with horizontal or vertical floats for wide range of proportional band requirements.



The float actuated 2800 series is a low cost, snap acting liquid level control available with either electric (explosion-proof) or pneumatic switch action. Pilot is interchangeable on float housing assembly. Features the stab-in type of tank mounting for easier installation. Write for Bulletin F2800 for complete information.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD...CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England



SINCE 1880

Valve diaphragm of R/M TEFLON* helps speed production of polio vaccine!

Here's how Raybestos-Manhattan co-operated with a customer to make possible faster production of vitally needed Salk polio vaccine.

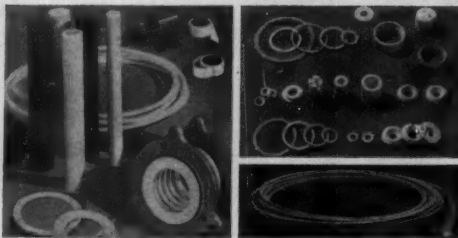
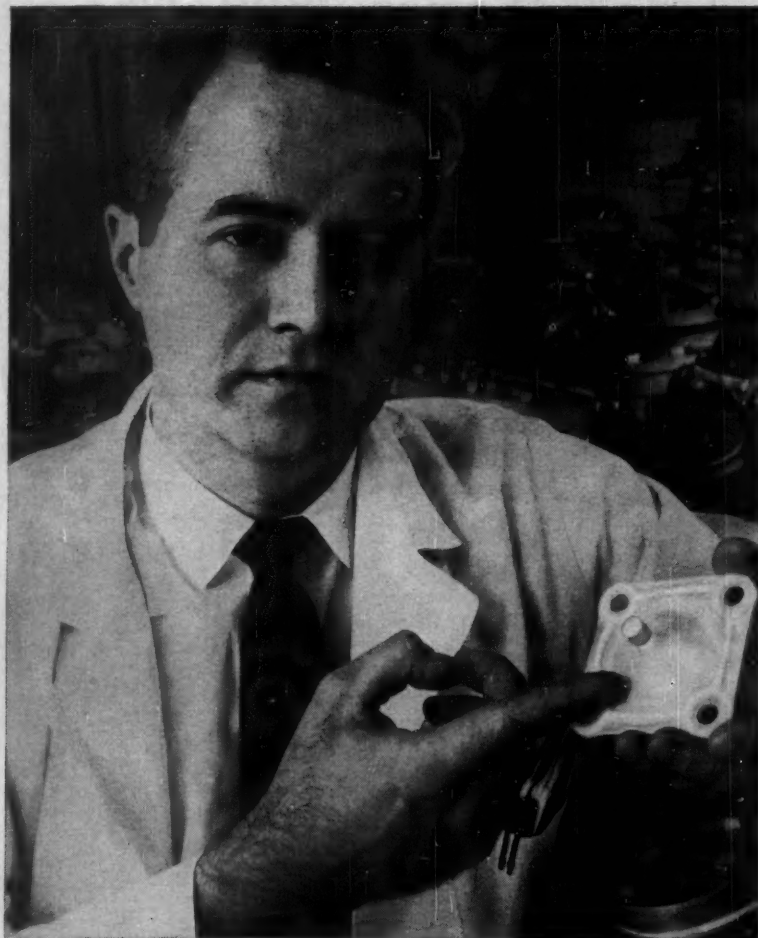
Salk vaccine is 20 days in the making, requires another 110 for testing. During this time the portable processing tanks must be sealed off from all possibility of contamination. Processing temperatures range from 5 to 150°C. Diaphragm valves were chosen for this work because they make possible complete cleaning and sterilization.

The solid valve diaphragms originally used were unable to withstand the extreme operating conditions involved. R/M "Teflon" was selected for the task because of its strength, flexibility, chemical inertness, and capacity to endure—unchanged—the wide range of temperatures necessary.



R/M worked closely with the customer and promptly developed a new method of molding a "Teflon" valve diaphragm ideally suited to this exacting need. The new "Teflon" diaphragm was much thinner than the one formerly used, with improved flex life that permitted a greater number of manufacturing cycles—this without danger of valve failure at a critical point in the process.

*A DuPont trademark



Other R/M products for the chemical industry include flexible thin-wall "Teflon" hose; custom-machined parts; rods, sheets, tubes and tape; centerless ground rods held to very close tolerances; stress-relieved molded tubes and rods; gaskets, expansion joints, and flexible couplings; bondable tape and sheets for linings; Raylon (R/M trade name for mechanical grade "Teflon") which has many characteristics of virgin "Teflon."



RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION FACTORIES: MANHEIM, PA.; PARAMOUNT, CALIF.

Contact your nearest R/M district office listed below for more information or write to Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.
BIRMINGHAM 1 • CHICAGO 31 • CLEVELAND 16 • DALLAS 26 • DENVER 16 • DETROIT 2 • HOUSTON 1 • LOS ANGELES 58 • MINNEAPOLIS 16
NEW ORLEANS 17 • PASSAIC • PHILADELPHIA 3 • PITTSBURGH 22 • SAN FRANCISCO 5 • SEATTLE 4 • PETERBOROUGH, ONTARIO, CANADA

RAYBESTOS-MANHATTAN, INC., Engineered Plastics • Asbestos Textiles • Mechanical Packings • Industrial Rubber • Sintered Metal Products • Rubber Covered Equipment
Abrasive and Diamond Wheels • Brake Linings • Brake Blocks • Clutch Facings • Laundry Pads and Covers • Industrial Adhesives • Bowling Balls

RECIRCULATION MAY BE KEY TO FUTURE GROWTH OF CHEMICAL AND INDUSTRIAL PROCESSES

● AN ADAMS REPORT Number 2 of a Series

How much water do you need to make: a ton of steel? a ton of synthetic rubber? a ton of bromine? a barrel of beer?

These are not empty questions. They point to a critical problem which confronts management today in its plans for tomorrow. It is more critical than most of us realize... for industry today uses as much water as all other users.

Industry's Needs in 1975

Water is vital for chemical and industrial growth. By 1975, industry will require 215 billions of gallons daily. That is a 100% increase over our current industrial consumption... more than we currently consume for all uses combined.

Competing for this water will be irrigation farmers and the general public. Their combined needs by 1975 will be up 40 billion gallons a day... possibly even more.

What is the Supply Picture

More than 40% of the communities in the United States already have a critical water supply problem. Yet, to meet the 1975 needs, our supply must be expanded by 50%, at an estimated cost of \$50 billion.

Indications are that industry is going to have to bear its part of this cost. Certain communities are already moving to place flat water rates on all users... regardless of the volume used. Other groups are demanding a national water policy with full Federal Government regulation of natural sources.

Chemical Industry's Stake

Shortage of water can be a most serious threat to the expansion hopes of the chemical industry. A glance at the following table shows why. You need approximately:

20,800	tons of water per ton of	Bromine
2,500	" " " " "	Synthetic rubber
830	" " " " "	Viscose rayon
300	" " " " "	Newsprint
208	" " " " "	Smokeless powder
15	" " " " "	Coke from coal

While process refinements may be able to reduce slightly the amount of water needed for each product, the gains will be minor.

Difference Between Use and Consumption

This is best illustrated by the water needed to make a ton of steel. The industrial average is 65,000 gallons (271 tons). In the past, 65,000 gallons of water flowed out of a river through the steel mill and back into the river again for each ton of steel made. In this case, use and consumption are one and the same thing.

On the west coast, a large steel mill now requires only 1,100 gallons of makeup for each ton of steel produced. This steel mill has its own recirculation system which holds several million gallons of water.

This water is recirculated at a rate equal to 65,000 gallons per ton of steel produced. The only water consumed is that lost due to evaporation or through leakage. Thus, net consumption has been reduced to 1,100 gallons.

Two Bulletins Available

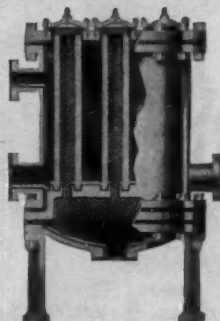
One of the most important pieces of equipment in a recirculation system is a filter. Where high quality process water is needed, diatomite filters will provide an effluent second only to distilled water. Bulletin 651, released by the R. P. Adams Company, Inc., 507 E. Park Drive, Buffalo 17, N. Y., covers this type of industrial water filter.

A second publication, Bulletin 909, covers an Automatic Water Filter which is frequently used in recirculation systems where the water is used for less critical applications. This bulletin is also available on request from the R. P. Adams Company at the above address.

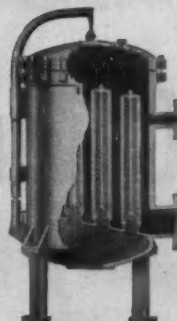
By the way, it takes almost two tons of water to brew a barrel of beer.

NEED A FILTER? FOR CORROSIVE LIQUIDS

Adams CFR are rubber lined filters which meet corrosion problems which require this type construction. Where lead lining is a must, the Adams CFL filter will meet your needs. Each tubular element of either filter may be removed individually for inspection, or replacement.



Adams CVF Filters are available in carbon steel, stainless steel, Monel and Nickel construction. Also constructed with submerged head for personnel safety and with outer jacket for use with steam or refrigerated coolant to maintain desired temperature.



► All Adams Filters provide safe cleaning without disassembly by a sudden, high velocity reverse flow of backwash liquid.

Do you have a filtration problem where corrosive liquids must be given a high polish? Where there is danger to personnel? Where there is a problem of temperature control?

The R. P. Adams Company has a line of filters which will solve any one of these problems... or a combination of all.

We may not have the answer to *your specific* problem, but the chances are we do. For the fastest action, we suggest you use the coupon below, or write for Bulletin 431 on your company letterhead.

R. P. ADAMS COMPANY, INC.

507 E. PARK DRIVE
BUFFALO 17, NEW YORK

R. P. ADAMS COMPANY, INC.

207 E. PARK DRIVE — BUFFALO, 17, NEW YORK

S-58

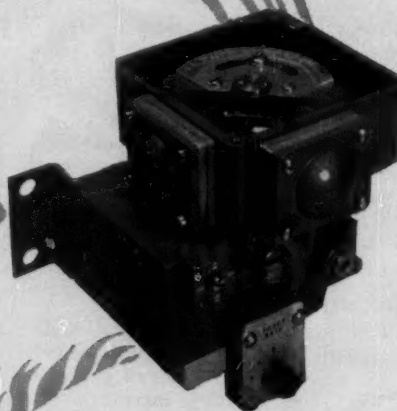
We have a problem involving the filtration of corrosive liquids. Please send us your Bulletin 431. Also, ask your local representative to call on us.

Name _____ Title _____
Company _____
Street _____
City _____ State _____

FLOW

PRESSURE

TEMPERATURE



Control Any Process Variable

with a system based on

REPUBLIC'S NEW TYPE "VC" PNEUMATIC CONTROLLER

Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action. Local or

remote pneumatic set point optional.

Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square-root-extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show

you how these instruments can help to achieve accurate, efficient, dependable control systems. Republic Sales Offices are located in principal cities throughout the U.S.A. and Canada.

REPUBLIC FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic
instrument and control systems for utility,
process and industrial applications.



Sift it Fine and Fast ...right into the mixer

Reciprocating vertical and rotary motion of the screen in Readco vibrating sifters make it possible to sieve and aerate powdered and granular materials at high speed with maximum control. The illustration below shows the sifter mounted on twin Readco ribbon mixers. Here screw conveyors and screw elevator carry materials to the sifter, which discharges directly into the mixers.

Readco sifters are built in capacities to suit any production requirement, with ready adaptability to materials handling systems.

For information on specific applications, write to Read Standard Division of Capitol Products Corp., York, Pa., attention of Sales Manager, Chemical Equipment.

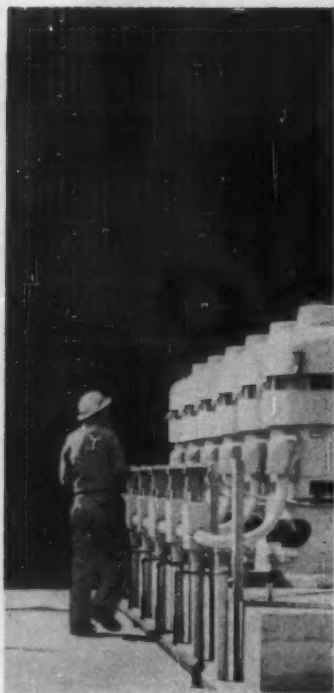


For more information on Readco processing equipment for the chemical industry, see Chemical Engineering Catalog, pages 1567 to 1574D.

READ STANDARD

York, Pennsylvania

A Division of
Capitol Products Corporation



to cooling: a solution

By trunk or by tower, evaporative cooling has proved its practicability. Contributing to the effectiveness of this method of industrial cooling is the Peerless vertical industrial service pump. Efficient, versatile and economical, the Peerless vertical pump offers optimum performance in all ranges, plus these *extra value* Peerless features: *unitized pump-motor manufacture*, for perfect alignment, increased pump durability; *improved suction manifolding* for better water intake, less friction; *advanced vertical turbine design* for highest efficiency, maximum performance; *designed-in flexibility* of a modern pump, for easy adaptation for future system requirements.



WRITE FOR ILLUSTRATED BULLETIN NO. B-505

Putting Ideas to Work

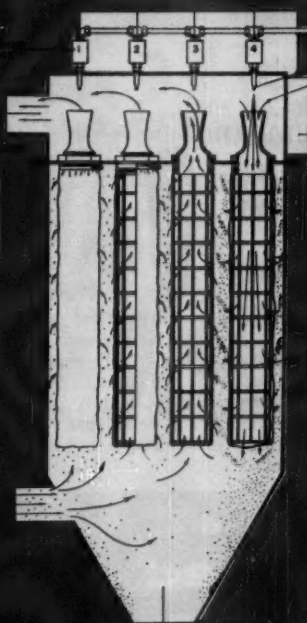


FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump Division

Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

Offices: New York; Atlanta; St. Louis; Phoenix; San Francisco; Chicago; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque. Distributors in Principal Cities. Consult your telephone directory.



--- JET-ACTION does the job!

CONTINUOUS, AUTOMATIC SELF-CLEANING!

**NO
MAINTENANCE
DOWN
TIME!**

the

MIKRO-PULSAIRE* COLLECTOR

Successful processing operations demand around-the-clock dust collection and full-time automatic cleaning . . . with no interruptions for maintenance. Jet-action MIKRO-PULSAIRE answers these requirements . . . does a better job at less cost. There are no internal moving parts to cause tie-ups . . . extra-long filter media life is assured . . . and MIKRO-PULSAIRE shows a performance-proven filtering efficiency of 99.9% plus! Bulletin 52A gives full facts and figures. It's yours for the asking.

For additional product information and location of the MIKRO-MAN nearest you, see Chemical Engineering Catalog for 1958, pgs. 1467 to 1474.



ASK THE MIKRO-MAN TO CALL!

We'll arrange a working demonstration of the MIKRO-PULSAIRE Model Unit right in your own plant or office . . . working on your own materials. Write for details.

A COMPLETE LINE OF UNITS FOR ALL COLLECTION JOBS, FEATURING:

- Continuous, automatic cleaning
- Ease and simplicity of maintenance
- No internal moving parts
- No shaking or frictional action on filter
- Efficiency 99.9%+

Mikro-D

PULVERIZING MACHINERY DIVISION
METALS DISINTEGRATING COMPANY, INC.
55 Chatham Rd., Summit, New Jersey

**GENUINE MIKRO-D
REPLACEMENT PARTS
AVAILABLE FROM
LARGE STOCK
WITHIN 48 HOURS**



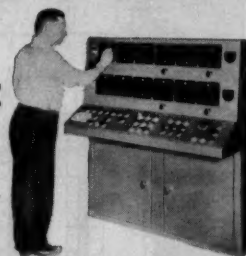
**LOOK TO TOLEDO for Progress
in the World of Weighing**

MULTI-SCAN FOR WEIGHING ITEMS IN MOTION

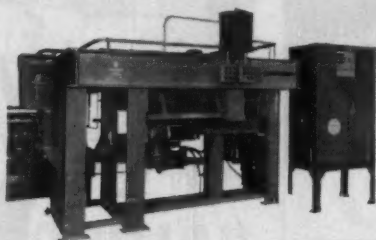
For items moving on overhead tracks (hog carcasses, for example) Toledo Multi-Scan system provides accurate average weights without necessity of bringing the swaying carcasses to rest. Weight data is fed into remotely located adding or other office machines for listing and totalizing of weights. Identifying data may also be introduced through key input stations.



AUTOMATIC BATCHING SYSTEMS



"Remocon" controls feature remote setting for fully automatic operation. Simple dial knob adjustments control quantities of each ingredient, allow precise duplication of batches. Extremely flexible — use with a single scale or multiple scale batching system.



PRODUCT TESTING AND CLASSIFYING

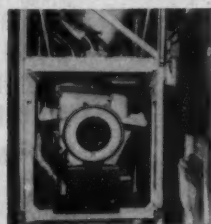
This custom-engineered Toledo automatically tests and classifies large coil springs. It is one of many types of Toledos used for classifying a wide range of items — from small packages to large cartons and production parts — in a variety of manufacturing operations.

Check These Specialized Jobs TOLEDOS Are Doing

When you have a problem in weighing, testing, counting, batching, sorting or weight data processing . . . and you want the practical, economical answer . . . it will pay you to check with Toledo. Toledo's complete line of industrial scales provides today's effective answer for a wide range of needs; or for special applications, Toledo Scale engineers will work with you on modifications or completely custom-engineered units. Toledo's huge reservoir of experience is your assurance of a practical, cost-saving solution. Let us help you. Write TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio.

AUTOMATIC BULK WEIGHING

Toledos provide accurate, net weight listing and totals of bulk materials going into truck or carload shipments. Weighing is automatic. A Toledo weight-control console with automatic recording and totalizing unit may be remotely located for operating convenience.



TOLEDO HEADQUARTERS FOR
WEIGHING SYSTEMS

ELECTRONIC AND HYDRONIC SCALES

Toledo Electronic Scale heads may be remotely located wherever convenient, because there are no mechanical connections. Toledo offers full electronic scales, also combinations with hydraulic or mechanical components to meet a wide range of requirements. For specific applications, digital indication of parts counts may be provided electronically.





How you can be sure to get the capacity you pay for in a cooling tower...

Thousands of gallons of water pour through a cooling tower every minute. If it goes in hot and comes out cold... if it keeps a plant's process water reasonably cool—is it safe to assume that the tower is doing its job... that the owner is getting his money's worth out of it?

Definitely not!

A tower may actually be operating at only a portion of the capacity paid for—without the owner's knowledge. Its heat transfer efficiency may fall short of specifications. Operating horsepower requirements may be higher than they should be.

How can you tell?

By conducting thorough field performance tests. But if the tower proves deficient, you can correct it only by increasing horsepower or the size of the tower—or both. Even though the manufacturer stands behind his product, you are put to additional expense, you may lose valuable production because of down time during the reconstruction, and your operating power costs may be increased for the entire life of the tower.

Obviously, the best thing is to *know* the capacity before you buy.

How? Well, you *can* accept the manufacturer's guarantee. But how

many manufacturers *really* know? Determining the capability of a cooling tower is an exacting science, requiring highly specialized knowledge of a wide variety of factors influencing performance.

Portions of such knowledge have been published in the past but much has been retained by cooling tower manufacturers as "private and confidential" data. But now, Pritchard has gathered all this information, refined it, added to it field-tested findings from our own research facilities, and arranged it into usable form. This reservoir of knowledge has been published under the title, "Counterflow Cooling Tower Performance," and is avail-

able from Pritchard for \$3.00. For your copy, mail the coupon below with your check or money order.

No book alone, however, can guarantee cooling tower capacity. That is the responsibility of experienced Pritchard engineers, who translate the information contained in the handbook into cooling tower designs that give you performance, not promises... real long-run economy, not first-cost-only economy.

The result is that when you buy from Pritchard, you buy with full confidence that you get what you pay for. You can rest assured that your Pritchard tower will deliver the capacity you specify.



J. F. PRITCHARD & CO. OF CALIFORNIA

Dept. 101, 4625 Roanoke Parkway, Kansas City 12, Mo.

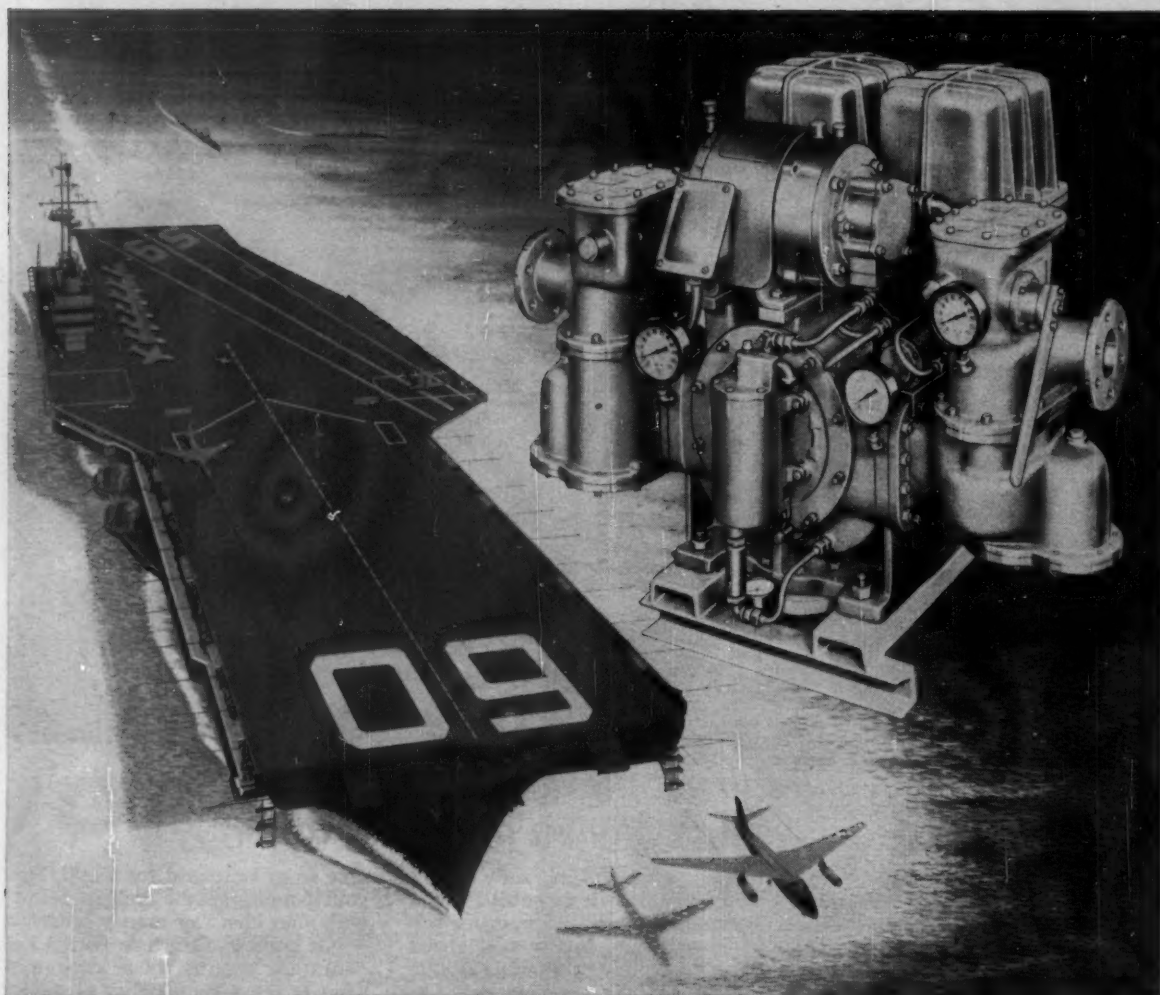
- ☐ Enclosed is \$3.00. Please send copy of "Counterflow Cooling Tower Performance"
- ☐ Please send free copy of new Counterflow Cooling Tower Bulletin 4.9.080A
- ☐ Please have your representative call on me

Name _____ Title _____

Firm _____

Address _____

City _____ Zone _____ State _____



How Kanigen® coating helps eliminate rust from jet fuel systems

Fuel systems engineers faced a major problem in corrosion when jet aircraft went to sea. Aircraft carrier systems for fueling planes are aqua-systems—which means that to prevent accumulation of explosive vapors in half-empty tanks, water replaces fuel as it is pumped out of the carrier storage tanks. Blackmer fueling units, made by Blackmer Pump Company in Grand Rapids, Michigan, frequently are used.

High test aviation gasoline does not absorb moisture. Jet fuel does.

This moisture, with high salt content, reaching unprotected steel castings, created rust which contaminated the fuel and caused malfunctioning.

Blackmer pumping units, made from steel castings to meet high shock requirements, were protected with KANIGEN® nickel-alloy coating. They were used and evaluated at sea for two years.

The KANIGEN coating was found superior because (1) it gave better initial overall coverage, and (2) the KANIGEN coating did not

chip or break away from machine surfaces as some other coatings do.

If you have a corrosion problem, consult our engineers. You'll find . . . it pays to plan with General American.

KANIGEN®

is a trademark which identifies chemical nickel coating by GENERAL AMERICAN TRANSPORTATION CORPORATION and its licensees, the product resulting therefrom and compositions produced by them for use in chemical nickel coating.

KANIGEN DIVISION

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street • Chicago 90, Illinois

Offices in Principal Cities

STAINLESS STEEL*



TO MARK PROGRESS



FITTINGS

$\frac{1}{8}$ "

THROUGH

36"

LADISH

...FOR COMPLETE SERVICE

IN *Controlled Quality* FITTINGS

When you need service in stainless and alloy fittings... regardless of material specification, size, type, or wall thickness... you can depend on the Ladish Controlled Quality line and the services of your Ladish Stainless Distributor for complete satisfaction.

IPS WELDING
FITTINGS



$\frac{1}{2}$ " through 36"
From Sch. 5S to wall
thicknesses through 5"

O.D. TUBING
FITTINGS



1" through 36"
From .049" wall to
.250" wall

MSS AND ASA
FLANGES



1" through 24"
150 lb. through
2500 lb.

150 LB.
SCREWED FITTINGS



$\frac{1}{8}$ " through 4"

FORGED SCREWED
AND SOCKET
FITTINGS, UNIONS



$\frac{1}{8}$ " through 4"
2000 lb. through
6000 lb.



TO MARK PROGRESS

LADISH CO.

CUDAHY (Milwaukee Suburb) WISCONSIN

Branch Plants: Milwaukee & Kenosha, Wis. • Los Angeles • Houston • Brantford, Ont., Can.

SALES OFFICES: Amarillo • Atlanta • Baton Rouge • Brantford, Ont. • Buffalo
Calgary • Chicago • Cincinnati • Cleveland • Denver • Havana • Houston
Los Angeles • Mexico City • Montreal • New York • Odessa • Philadelphia
Pittsburgh • St. Louis • St. Paul • San Francisco • Seattle • Toronto • Tulsa

*Also furnished in any forgeable material specification including...
Titanium, Aluminum, Copper, Nickel, and Chromium Base Alloys.

The Arithmetic of Materials Handling



Fuller Airveyor unloads wood flour to two forty-five foot silos. Second Airveyor system reclaims material 360 feet to processing.

General Electric Changes From Bags to Airveyor ... Cuts Handling Costs 60%

As part of a program to increase plastics production and reduce operating costs at its Pittsfield, Mass. plant, General Electric Company called in Fuller engineers to design systems for handling wood flour in bulk.

Wood flour—used as a filler in phenolic molding compounds—was being handled in 75 and 100-pound bags. Unloading one carload of bags required 16 manhours. Bags were loaded on dollies and wheeled to a distant elevator.

SAFETY FIRST—The two pneumatic Airveyor® materials handling systems, engineered and manufactured by Fuller Company, were installed by its parent company, General American Transportation Corp., providing undivided responsibility. This installation resulted in a 60% saving in handling costs! The two systems

are handled by one full-time and one part-time operator. Manhours to unload one car have been reduced from sixteen to six!

In addition, all equipment is designed to conform to strict safety specifications set down by G-E engineers.

FLOW YOUR MATERIALS—The Airveyor is a system that flows your material through sealed pipes. It's fast, safe, and self-contained. The pipes can be placed close to ceilings, run underground or through walls.

Whether you process wood flour—or other dry granular materials—look into the many economies of Airveyor conveying. Write today for interesting, detailed literature on Airveyor and other Fuller pneumatic materials handling systems.



G-198
1304



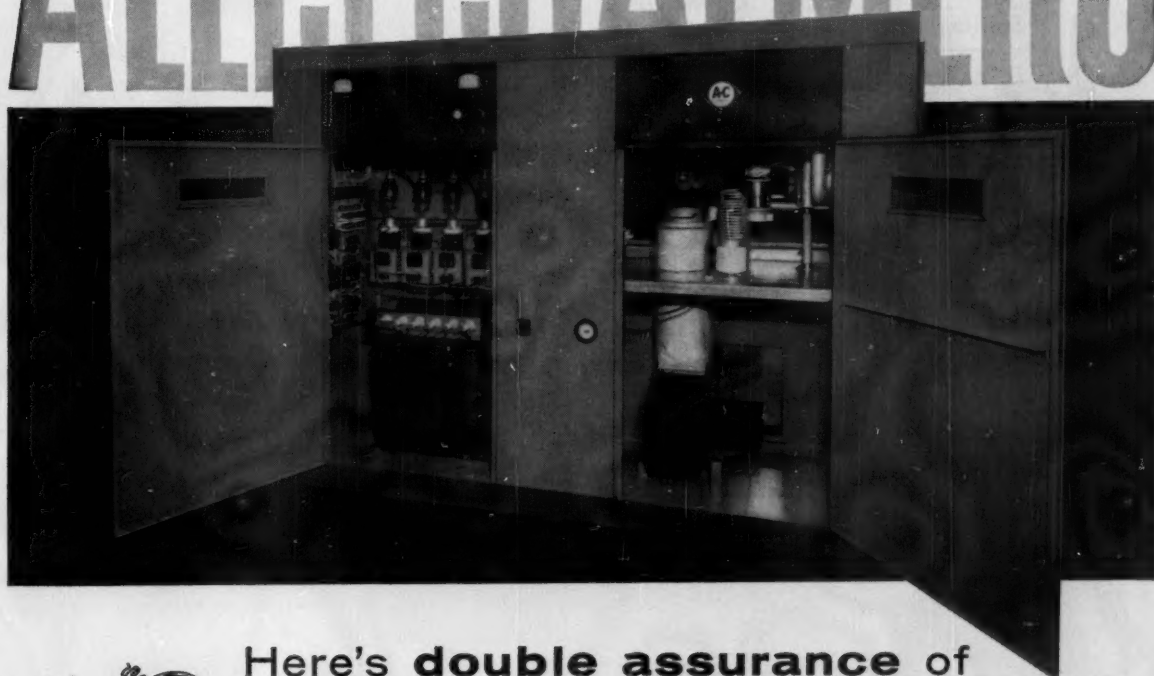
FULLER COMPANY

134 Bridge St., Catasauqua, Pa.

SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Birmingham • Chicago • Kansas City • Los Angeles • San Francisco • Seattle

"See Chemical Engineering Catalog for details and specifications".

ALLIS-CHALMERS



Here's **double assurance** of
complete satisfaction in
dielectric heating

1. The heater

The expertly crafted enclosure tells you — here's quality. Operating convenience is immediately apparent in the eye-level grouping of controls. Protective interlocks are representative of many safety features. And behind the easy-access doors you'll find engineering, workmanship and components that mean standout performance and dependability. For example, the water-cooled oscillator is built for 5000 hours of service. The heavy-duty plate transformer has a large reserve capacity. Clean wiring arrangements, bakelite standoff, ceramic coils, sturdy relays are just a few more reasons why the Allis-Chalmers dielectric heater is preferred equipment.

2. The manufacturer

When you specify Allis-Chalmers, skilled electronic engineers help plan the most efficient use of your dielectric heating. The modern A-C laboratory is at your disposal for material testing. Services include the design of work-handling equipment. Installation is supervised by a trained field engineer. Periodic checkup and emergency maintenance service are also supplied by Allis-Chalmers regional offices conveniently located near you.

See your Allis-Chalmers representative for complete details or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. Ask for Bulletin 15B6431C.

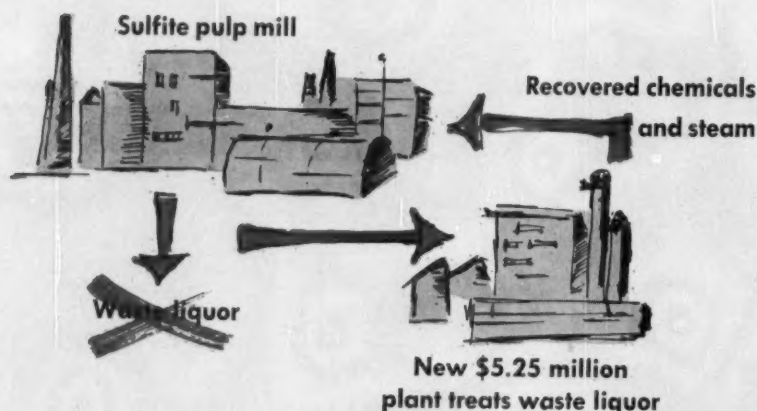


A-5774

ALLIS-CHALMERS

PROCESS FLOWSHEET

C. H. CHILTON



Plant burns waste liquor to recover MgO , SO_2 and steam. $\text{Mg}(\text{OH})_2$ absorbs SO_2 to make fresh liquor.

Magnesia Process Buttons Up Sulfite Pulping

To win freedom from restrictive pollution controls, Brown Co., Berlin, N. H., recently invested \$5.25 million to convert its 400 ton/day Burgess sulfite mill to magnesia-base pulping and chemical recovery (see p. 60).

With this expenditure, Brown has shut off flow of waste pulping solids to the Androscoggin river from 240 tons/day of pulp production. And by integrated processing of the waste, Brown recovers for reuse 80-85% of the magnesia and 90% of the sulfur. At the same time, the operation produces 160,000 lb./hr. of 450-psi. steam (ultimately 850 psi. after installation of turbine).

► **Burn to Recover**—Brown's recovery process hinges on successful combustion of the organic waste to liberate heat for pyrolysis of the inorganic pulping chemicals and for production of large quantities of valuable byproduct steam. Subsequent steps convert the pyrolysis products back to fresh magnesium bisulfite pulping liquor.

From beginning to end, Brown's system reflects concentrated en-

gineering effort to wring maximum return from the \$5.25 million outlay.

► **Control Starts at Digesters**—Controls imposed to obtain such return reach way back to the pulp mill digesters. To hold liquor concentration high and reduce evaporator load, the pulp mill operates its digesters with a low ratio of cooking acid to wood. And to avoid dilution during digestion, the mill heats liquor by circulation through external heaters, rather than by direct steam injection.

After completion of digestion, pulp discharged from the digesters passes over countercurrent vacuum washers which recover the waste liquor at 11-15% solids content.

► **Concentrate Before Burning**—In order to burn well in the recovery furnace, waste liquor must contain approximately 55 to 60% solids.

From the washers, dilute liquor feeds into the 3rd effect of the stainless-steel Sandvik-Ramen evaporator at 500 gpm. Leaving the 6th effect, liquor contains 25% solids. Concentration of the liquor from 25 to 60% solids takes place

at high temperature in the 1st and 2nd effects.

Sulfur dioxide gas liberated from the liquor during evaporation is vented from the dirty condensate gathering system through jet condenser and vacuum pump to flue gas absorption system.

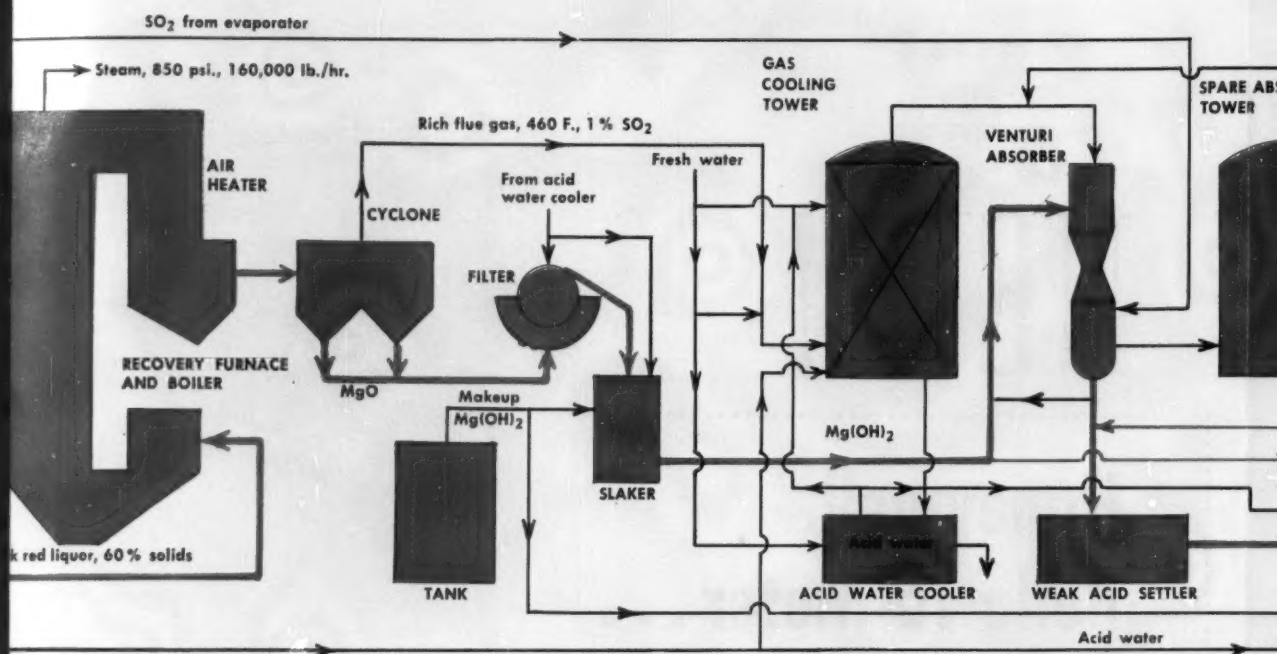
► **Furnace Key to Recovery**—Concentrated 60% liquor from evaporator passes through storage tank and booster heater before entering combustion zone of furnace through 12 opposed, steam-atomizing single-jet burners. Burning under self-sustaining, stable conditions, liquor yields dry MgO ash of high purity and reactivity, plus SO_2 .

Air for combustion passes through preheater section in flue to reach temperature of 730 F. before entering combustion zone. This is essential to successful drying, volatilizing and burning of the waste material. Otherwise, the air (3.5 units by weight per unit of 60% liquor) would soak up sufficient heat in the combustion zone to retard combustion, producing carbon and poor quality magnesium oxide.

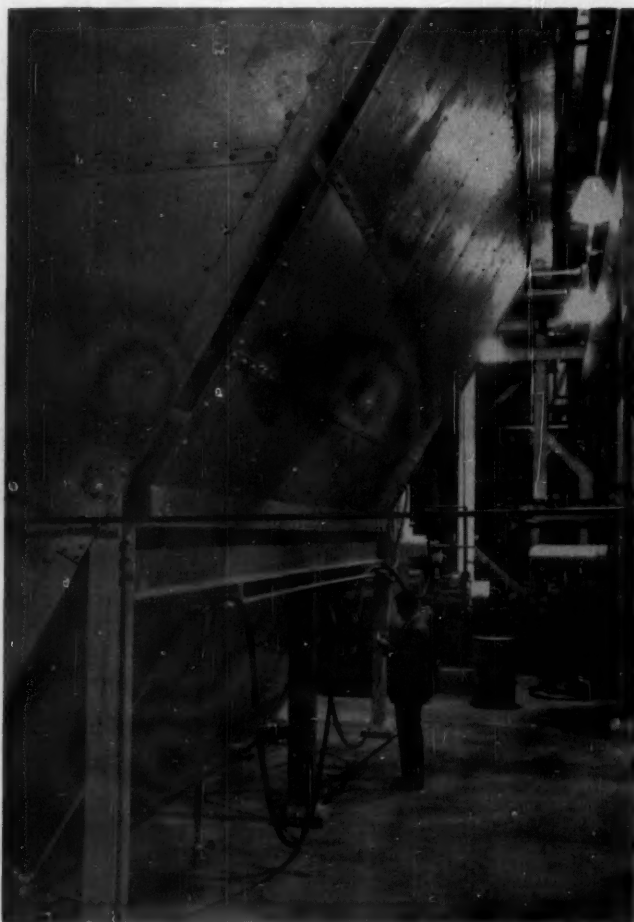


Unfold Flowsheet





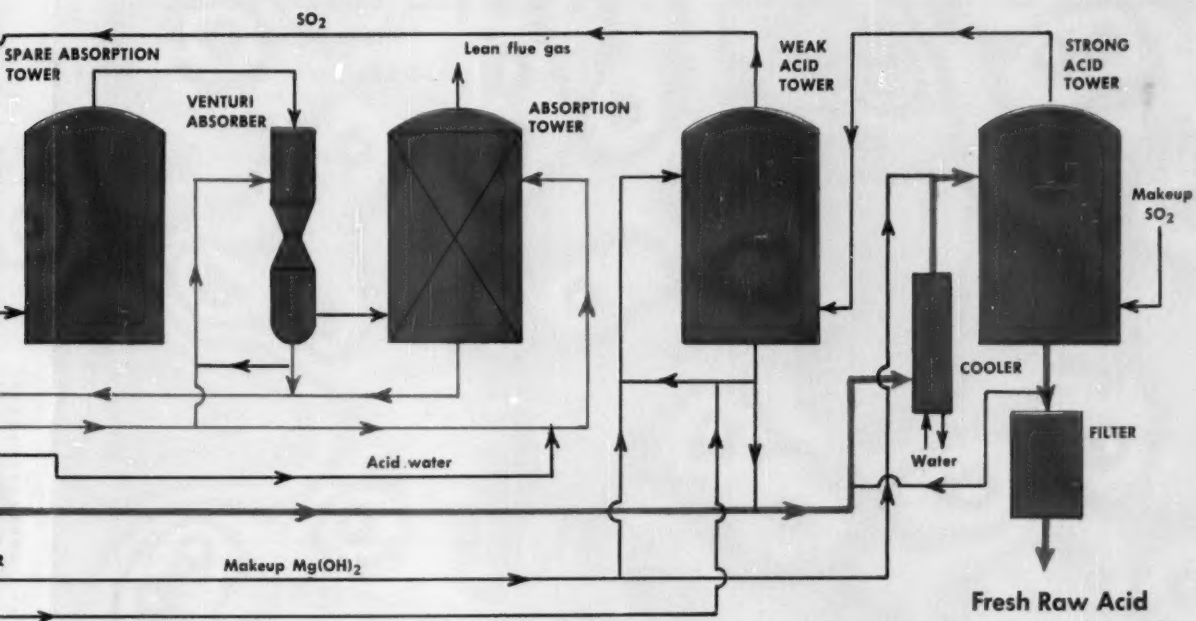
Red liquor is converted to waste to combustible level.



CONVERSION of bisulfite to MgO and SO_2 occurs during drying and combustion of organic solids within furnace (bottom shown).



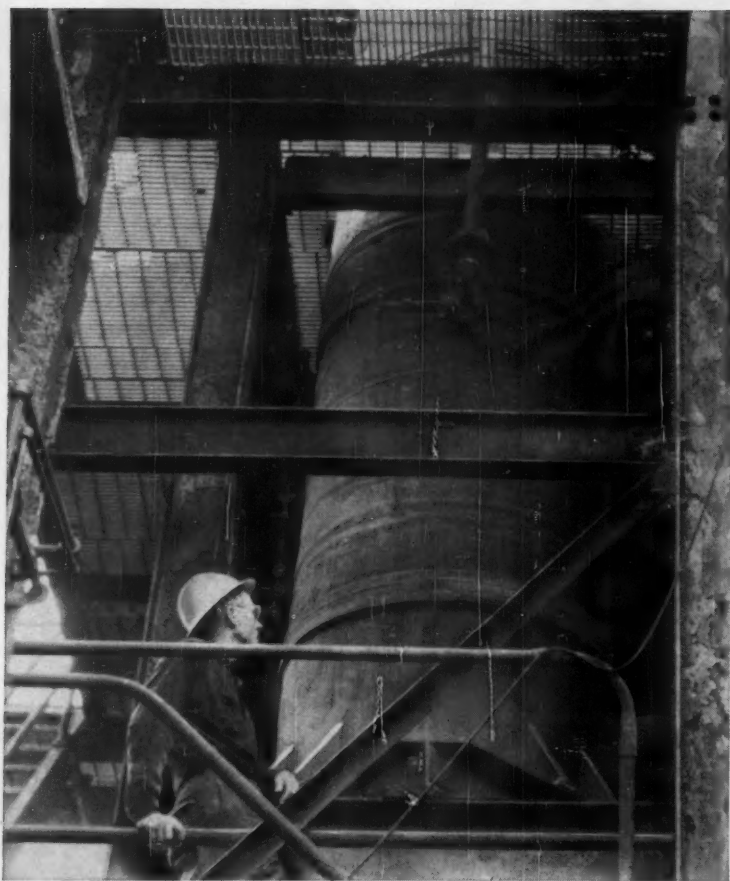
RECOVERY of MgO from waste liquor, which this filter removes.



MgO from flue gases carries along soluble impurities and is removed before MgO is slaked to Mg(OH)₂.



ABSORPTION of SO₂ from flue gas by Mg(OH)₂ in venturi absorber produces fresh magnesium bisulfite liquor for pulp mill digesters.



Results of 133-day Plant Corrosion Tests in Distillation and Rectification of Crude CCl_4

TEST 1

Suspended in vapor stream above top plate of bubble cap rectification column. Approximate analysis of vapor:

Carbon Tetrachloride 99.398%
Sulfur Chloride 0.600%
Carbon Bisulfide 0.002%

Temperature: 78°C. (171°F.)

TEST 2

Suspended in reboiler for column, completely immersed in liquid with following approximate analysis:

Sulfur Chloride 98.30%
Carbon Tetrachloride 0.13%
Iron as FeCl_3 0.01%

Temperature: 138°C. (280°F.)

CORROSION RATE

	TEST 1 ipy.**	TEST 2 ipy.
Monel	†	†
Nickel	†	†
Inconel	†	†
Ni-Resist (Type 5)	†	0.001
Ni-Resist (Type 1)	†	0.002
Mild Steel	0.008	0.217
Cast Iron	0.007	0.128

**inches penetration per year †less than 0.001

Maintenance cost cut 90% in CCl_4 system

Using 3 different Nickel alloys, Westvaco runs column and reboiler 12 years. Savings exceed \$108,000

At Westvaco Chlor-Alkali Division of Food Machinery and Chemical Corp., corrosion by sulfur chloride had been causing failure of the bottom head of the reboiler in the CCl_4 system every 15 months. Other parts, too, had to be replaced frequently . . . running maintenance costs up to \$10,000 per year and more.

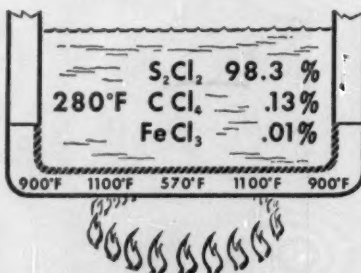
Engineers tested various materials in critical environments in the system. The data showed that several nickel alloys provided superior corrosion resistance. And the system was redesigned using these alloys. In the 12 years since, there have been no replacements of major units. Yearly maintenance has stayed below \$1000.

Reboiler bottom head

This item, originally cast iron, is now 10% Inconel-clad steel made by

Lukens Steel Co. with fire-box steel backing.

The Inconel* nickel-chromium alloy has high resistance to chlorinated organic solvents and also resists sulfidation at the high temperatures present. Sketch shows conditions.



Vapor, return and drop lines

These lines are all Monel* nickel-copper alloy.

Monel alloy provides protection against the small amounts of dilute hydrochloric acid likely to form by hydrolysis in these cool parts of the system.

Ni-Resist* high nickel cast iron completed the redesign. It was used for sides and top of the reboiler and for bubble caps, trays, and bottom sections of the still shell, which had originally been designed for cast construction.

Is your maintenance cost too high?

Is corrosion or high temperature the likely cause? Inco's Development and Research Section can help you pin down the facts and select corrective alloys.

*Registered trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

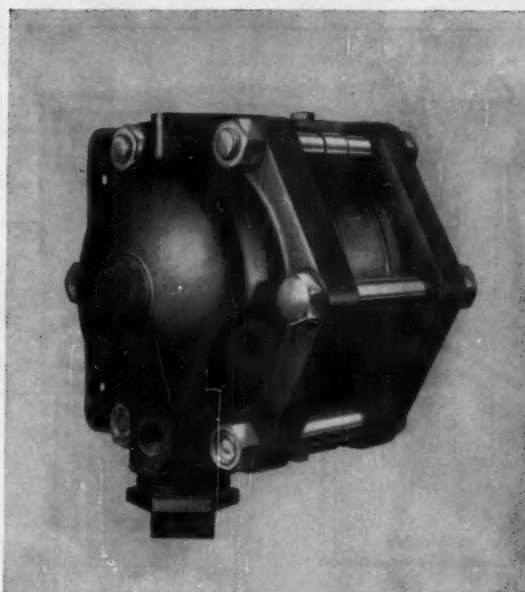


INCO NICKEL ALLOYS

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*unequalled for accuracy, stability, versatility
in flow and liquid level metering*



The new Honeywell Bellows Flow Meter gives the better performance demanded by its potential users. It's the most advanced meter body available today, with important advantages never before found in flow and liquid level meters.

Some of its outstanding features:

Sensitive and accurate—Sensitive to within 0.05% of full scale ... calibrated accuracy $\pm 0.5\%$ of full scale.

Leakproof—Between liquid fill and process fluid.

Automatically stabilized—Changes in meter body temperature or static pressure have no effect on output shaft position. The Honeywell Bellows Meter operates efficiently in surrounding temperatures of minus 40°F to plus 250°F.

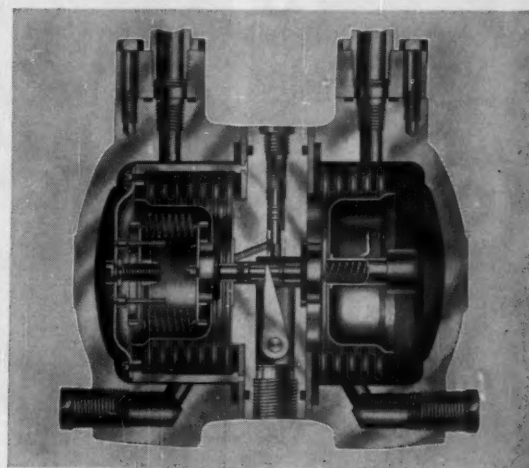
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Models are available in many ranges, for both flow and liquid level measurement and control. Get details on *all* the features of the new Honeywell Bellows Meter by calling your nearby Honeywell field engineer today ... he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.



REFERENCE DATA: Catalog C22-1

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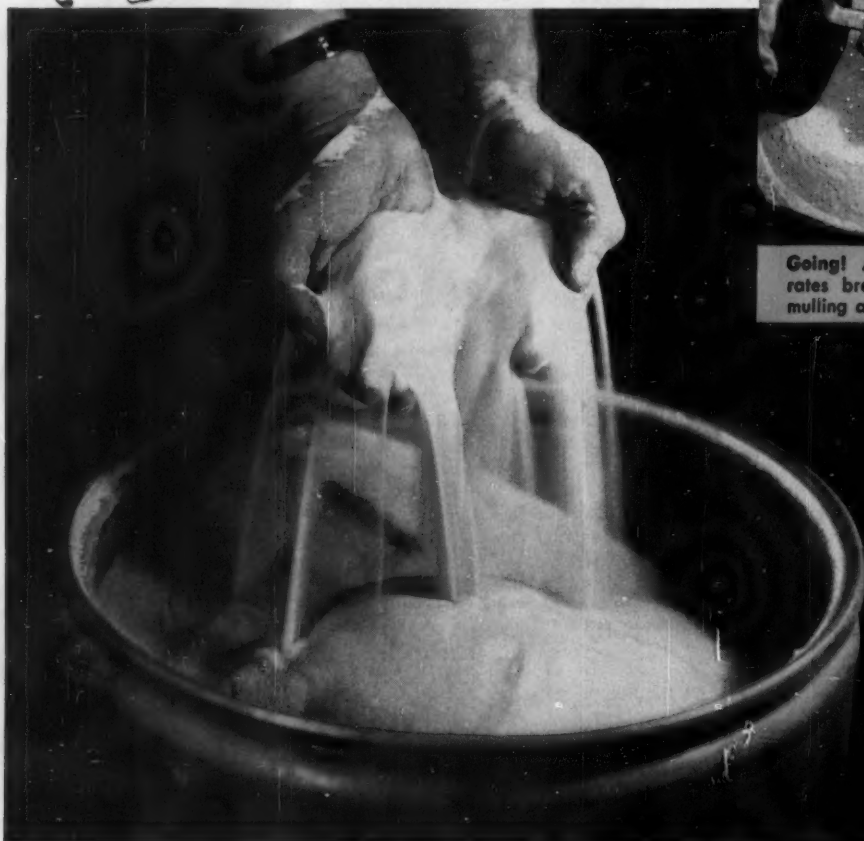
In the Simpson Mix-Muller a *three-way* kneading, smearing, spatulate action actually coats one material with another—rather than placing them *next* to each other. Agglomerates are broken up, moisture or binder dispersion is thorough. You get an intensive, homogenous mix that *stays* mixed and will not segregate in storage or transit. Want proof? Write for details on a confidential test. See what *mulling* can do and remember . . .



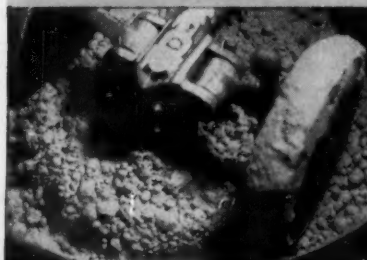
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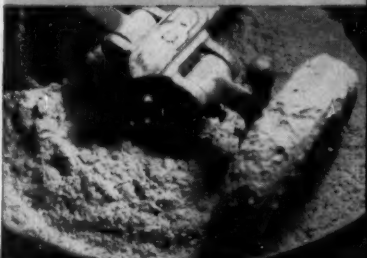
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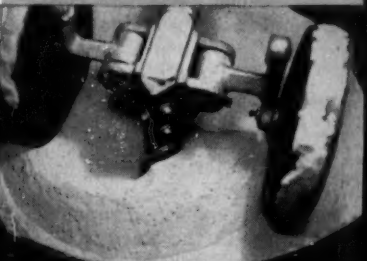
3 WAY ACTION
saves time
and reprocessing



Mix is wetted; dispersion of coating media begins.

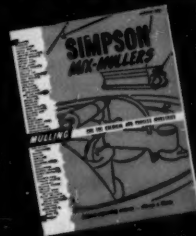


As mulling proceeds, mix begins to "lump" up as moisture is dissipated.



Going! As material dries agglomerates break down under intensive mulling action.

◀ Gone! Components are thoroughly blended. Mix is uniform, smooth flowing . . . quickly achieved.



WRITE FOR Bulletin on
*Mulling for the Chemical
and Process Industry.*

Chemical Engineering

Practice

SEPT. 8, 1958

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Magnesia process cures sulfite waste problem..... 114

Brown Co.'s new \$5.25 million switch to magnesia-base pulping and waste-liquor processing salvages chemicals and heat, reduces pollution of Androscoggin River.

Whip those materials of construction woes..... 123

Processing at moderate temperatures? Here's a 12-page report on nonmetallic inorganic materials of construction that'll beat the severest of conditions.

Quick way to calculate optimum heat exchangers..... 135

Here are some handy equations which quickly and easily give you the optimum terminal temperatures for your heat exchanger or exchanger-cooler designs.

Here's help for calculations of pipe diameter..... 138

Use this new chart, with relative roughness factors for the pipe, to lessen trial-and-error in calculating pipe diameter when you know flow rate and pressure drop.

Can you design for mass transfer in fixed beds?..... 143

Learn how to calculate the number of theoretical plates in mass transfer operations when one phase is stationary, as in adsorption, ion exchange and chromatography.

Use this yardstick on engineering effort..... 146

Formalized systems of job evaluation have worked for the large organization. Now, here's a scheme that will perform satisfactorily even in a small engineering department.

Now you can coat equipment with polyethylene..... 152

With this recently developed technique, process equipment can be coated with chemically resistant polyethylene at one-half the cost of most sheet lining materials.

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Series 2801 Gate Valve
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150-800 Pounds Service

To eliminate forever potential body-bonnet leaks, Vogt engineers have developed these new General Purpose valves with seal welded bonnet joints.

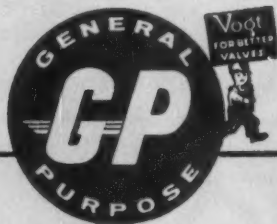
This new addition to the world's most complete line of forged steel valves incorporates all the features of other Vogt GP valves—hard faced seats, hardened stainless steel wedges, drop forged pressure parts, and the numerous other advantages of Vogt's valve line.

The desirable safety feature of a back seat on the stem is retained while still offering the elimination of a possible body-bonnet leak.

Available NOW in both gate and globe types, $\frac{1}{4}$ " thru 2", and in both socket weld and screw ends. These are priced identical to the bolted bonnet GP valves; gate valves the same as Series 1211 and globe valves the same as Series 12141.

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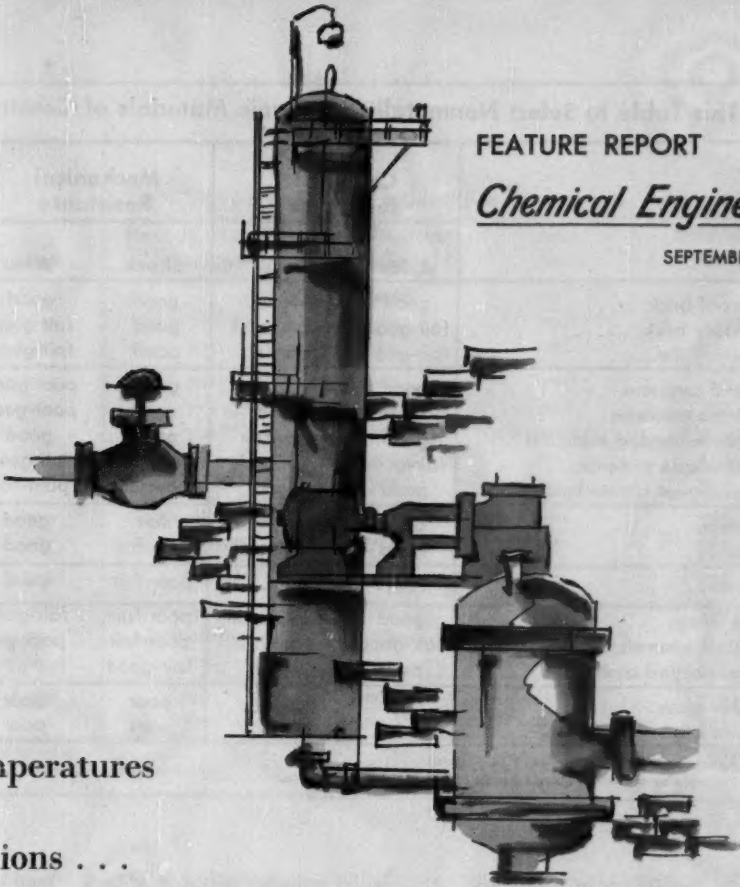


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FORGED STEEL

VALVES



FEATURE REPORT

Chemical Engineering

SEPTEMBER 8, 1958

For
Moderate Temperatures
and
Severe Conditions . . .

. . . Use Nonmetallic Inorganics

Severe conditions can knock your equipment out. Here's the lowdown on materials to handle these conditions.

MARTIN D. ROBBINS, Assistant Editor

How do you handle severe process conditions? What materials of construction are available to you the chemical engineer meeting these conditions of corrosion, abrasion and temperature?

We've covered (*Chem. Eng.*, April 21, 1958, p. 135; June 30, 1958, p. 105) the nonmetallic inorganic materials you'll use at temperatures impossible for metals. Now we'll cover the nonmetallic inorganics available for conditions at lower temperatures. Temperatures where you have a wide variety of materials to pick from—metals, organics or nonmetallic inorganics.

In selecting nonmetallic inorganic materials, or any other material, there are points to remember.

At the earliest possible stage, give attention to the job of materials selection. This avoids the problem of not knowing what material to use after you've put in a lot of engineering.

Do your materials testing well before the first engineering of commercial-size units. You'll avoid changes late in the design or fabrication stage. You run into cases where design must accommodate for severe conditions of corrosion, erosion or temperature. If it's too late in the design, changes are impossible and you accept inferior protection.

In fact, the availability of suitable or economical materials might be the determining factor in the

Use This Table to Select Nonmetallic Inorganic Materials of Construction

	Chemical Resistance		Mechanical Resistance		Thermal Resistance	
	Acids	Bases	Shock	Wear	Heat	Shock
Acidproof brick.....	good	fair	good	good	good	poor-fair
Refractory brick.....	fair-good	poor-good	good	fair-good	good	fair-good
Refractory tile.....	fair-good	poor-fair	good	fair-good	good	fair-good
Portland concretes.....	poor	good	good	poor-good	fair	fair
Aluminous concretes.....	poor-fair	good	good	poor-good	fair-good	good
Phosphate-bonded monoliths.....	good	poor-fair	good	good	good	good
Air-set silicate cements.....	fair-good	poor	fair-good	fair-good	fair-good	fair
Chemically-set silicate cements.....	good	poor	poor-good	poor-fair	poor-good	poor-fair
Porcelain.....	good	fair-good	fair	good	fair-good	poor-fair
Glass.....	good	fair-good	poor-fair	good	poor	poor
Cermets.....	poor-fair	good	good	poor
Glass linings.....	good	fair-good	poor-fair	fair-good	poor	poor
Porcelain enamels.....	fair-good	poor-fair	poor-fair	poor-good	poor-fair	poor-good
Flame-sprayed coatings.....	poor	poor	fair-good	fair-good	good	poor-fair
Cellular glass.....	fair	poor	poor	poor	poor	poor
Cellular silica.....	good	poor	poor	poor	good	good

A—Application in confined space is difficult.
C—Available space may be too small for necessary thickness.

commercial feasibility of a process. The choice of the proper material has a large affect on the cost of equipment.

Develop as much preliminary information as possible so you can make a systematic choice. Consult specialists in every field of materials selection that might be involved or in competition—metals, organics or nonmetallic inorganics. This is the only way you'll arrive at an expert, unbiased decision.

Monolithic Shapes

Perhaps the largest future outlet of nonmetallic inorganic materials for moderate-temperature service is the use of cements and concretes for monolithic shapes.

Cement and concrete present the largest variety of properties for application in the chemical process industries. Their availability, economy and installation ease make them sure bets for large-scale future use.

These materials do have their disadvantages: as for example, Portland concretes need a thickness of at least 1 in. and very often 2 in. or more. This means the minimum application thickness may be excessive for the available space. Never-

theless, its economy dictates its use.

Another cementitious material that's found widespread use in the chemical and petroleum industries is phosphate-bonded alumina. There are several varieties of this material bonded by phosphoric acid or by mono- or di-hydrogen phosphate.

Air-setting silicate cements consist of siliceous or factory aggregates bonded by alkali silicates. These develop strength and rigidity when their water evaporates.

Chemically-setting silicate cements contain siliceous aggregates bonded by alkali silicates. They also have acid salts or esters that cause rapid silicate precipitation as a gel.

Corrosion Protection is Good

Portland concretes aren't the most corrosion-resistant materials available. They're attacked by mineral acids even in low concentrations, by inorganic salt solutions and by many organic compounds. Frequently this chemical attack doesn't decide against your using them since the attack rate is rather slow. Most important, the economy of Portland concrete is why you must consider it in many areas where there's chemical attack.

At elevated temperatures, Port-

land concretes are resistant to most alkaline liquids and to most vapors. This leads to extensive applications for equipment linings in vessels, ducts and stacks.

Aluminous concretes have a broader range of chemical resistance than Portland concretes—particularly with mineral acids. In general, a good aluminous concrete will resist quiescent mineral acids in concentrations below 2–5%. Such concretes aren't seriously attacked by moderately moving liquids at a pH above 4 or 5.

Phosphate-bonded aluminas exhibit excellent resistance to acids and acid vapors. Unfortunately, with strong caustic solutions these materials lose their value.

Air-setting silicate cements are resistant to many acids and most vapors, but not to alkaline conditions.

Chemically-setting silicate cements are fairly permeable and those based on sodium silicate are subject to "sulfation" or "sulfate disintegration" under certain circumstances. This involves permeation of the cement by sulfuric acid. Sodium sulfate is formed which is precipitated by evaporation near the surface. The salt is hydrated to the $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ form, with a

Limitations			Can Be Used For . . .			
Size	Thickness	Shape	Heat-Resistant Facings	Wear-Resistant Facings	Gas Seal	Retaining Structures
A	C	yes	yes	yes	no*	yes
A	C	yes	yes	yes	no*	yes
A	C	yes	yes	yes	no*	no
A	C	no	yes	yes	yes	yes
A	C	no	yes	yes	yes	yes
A	none	no	yes	yes	sometimes	sometimes
A	none	no	yes	yes	no	no
A	none	no	sometimes	yes	no	no
A	C	yes	sometimes	yes	yes	yes
B	none	no	sometimes	yes	yes	yes
B	none	yes	yes	yes	yes	yes
B	D	yes	sometimes	yes	yes	yes
B	D	yes	sometimes	sometimes	yes	yes
A	D	no	yes	yes	no	yes
A	none	yes	no	no	yes*	yes
A	none	yes	yes	no	yes*	yes

B = Very large shapes are difficult to handle.
D = Usual thickness may not be enough for severe conditions.

* = Depends on jointing and mortar used.

large volume expansion and subsequent surface disintegration.

Evaporation from a sulfate-saturated cement body is required for this to happen, but it occurs frequently enough that you should think twice about using chemically-setting cements in many applications. Unless the cements are made with potassium silicate or otherwise compounded to prevent this trouble, don't use them in a situation that might lead to this form of spalling.

Concretes Must Be Anchored

For vessel linings, concretes usually are anchored to a metal shell by one of two methods:

Discrete Anchors—Small "V" or bent-pin anchors extending $\frac{1}{2}$ to $\frac{3}{4}$ the concrete thickness. These are welded to the vessel on centers two to four times the lining thickness.

Continuous Reinforcement—Metal fabric, such as welded wire mesh or poultry netting. This is spaced away from the vessel by no more than half the lining thickness and supported on studs, nuts or slab spacers welded to the vessel.

Expanded metal lath is sometimes used this way or in the form of a base as in wall plastering. In most cases it isn't especially satisfactory.

In construction, it's best to keep

the metal volume to a small fraction of the lining cross-section to avoid trouble.

First, for lining operation at above-ambient temperatures, the metal doesn't act as a reinforcement. In fact its high thermal expansion might create forces that rupture the concrete.

Secondly, concretes are permeable. They depend for protection on the slow diffusion rate of corrosives, or corrosion products. Formation of a small amount of solid corrosion product on the surface of the concrete also prevents further access of the corrosive to the metal. However, corrosion of metal reinforcement causes formation of a voluminous amount of material (especially oxidation or sulfide corrosion) that causes spalling of the concrete.

Concretes for corrosion protection are occasionally applied in the interstices of metal gratings—such as hexagonal floor gratings—welded to the vessel wall. In this case, the metal grating must be resistant to the service conditions. It must be tightly filled with concrete, and the welding must be expertly done. This construction is selected mainly when mechanical abuse or severe vibration is a service condition.

Phosphate - bonded monolithic

shapes are anchored in the same way as concretes.

Installation Procedures Vary

Concretes may be installed by:

- Pouring at stiff consistency with vibration—applicable only to substantial thicknesses.
- Trowling or slap-troweling.
- Hand-packing — especially into gratings.
- Pneumatic gunning.
- Ramming of very stiff mixtures.

Not all concretes lend themselves well to pneumatic application (cement-gunning). However, most can be handled with wet-mix equipment. Here, water and concrete are premixed before being blown through a hose and nozzle by air pressure.

Pneumatic application, done by skilled operators, yields the densest and strongest structures with the least shrinkage. Gas permeability in such structures is often so low it can't be measured by usual methods.

However, in most cases, any of the above installation methods are satisfactory. Just remember, you need skilled workmen under competent, conscientious supervision. The materials must be selected and adapted to the service and installation method.

Phosphate-bonded monolithic materials are generally intended for trowel installation. A few troweling mixes have strong air-setting properties. Others are installed by ramming. These and most troweling mixes have little or no air set and are hygroscopic.

All the phosphate-bonded materials undergo reactions at 500 to 600 F. that result in an extremely strong aluminum phosphate bond. Many times, this surpasses the hydraulic cements in strength, hardness, refractoriness and volume stability. Some have a tendency to bloat or laminate and most are slightly permeable.

Field installation is difficult since it's necessary to heat the entire thickness of the material to above 500 F. Installation procedures are similar to those for concretes.

Air-setting silicate cements adhere to proper metallic or inorganic nonmetallic substrates fairly well. However, they're subject to varying degrees of shrinkage and to "skin-ning" that may prevent proper drying of thick layers. You should, therefore, apply it by troweling in layers up to $\frac{1}{2}$ -in. thick. These can be multiple if desired, with or without an anchorage.

In some cases, you can use a layer of this type beneath an insulating vessel lining to prevent corrosion by condensates.

Chemically-setting silicate cements, unlike air-setting cements, have short working times—20 to 30 min. After this time they become resistant to water. Air-setting cements become water-resistant only after heating to temperatures above 600 F. or by washing with acids like sulfuric.

You can use chemically-setting cements in much the same way as you would a hydraulic cement but you shouldn't exceed an inch or two in thickness.

Chemically-set cements are usually less refractory than air-set ones, but they're less subject to shrinkage at their moderate service temperatures.

You can apply them by troweling, but some can be poured into forms. A few can be applied by cement gun, and some are dense enough to be used in thin coatings— $\frac{1}{2}$ -in. thick. These thin coatings have been used with reasonable success under certain conditions.

Porcelain and Stoneware

Chemical processing puts some pretty heavy demands on materials of construction. Today the chemical engineer is acquainted with a wide variety of materials, but there are many materials he overlooks because they are "old-line." Chemical porcelain and stoneware are notable examples. It's a fact that porcelains today are far different from those available ten or twenty years ago.

Now, what is porcelain? The American Ceramic Society has defined porcelain: a fired ceramic ware, conventionally white, having a vitreous body; if glazed, the body and glaze are matured in the same fire. A vitreous body has reached a state of increased density (decreased porosity)—developed through controlled heat treatment or the process involved.

What does this mean to you, as a chemical engineer, in search of new or better materials of construction. You have to look at the properties of these materials for a complete explanation.

Porcelain is made of purer raw materials than stoneware, and stoneware's fired properties aren't as good as porcelain. Throughout this section, the discussion of uses and properties of porcelain will be equally applicable to stoneware. Just remember: properties of stoneware do not measure up to properties of porcelain.

Corrosion Resistance: Outstanding

Porcelain (as well as stoneware) offers you almost universal corrosion resistance over a wide temperature range. Only hydrofluoric acid and strongly basic hydroxides affect this material appreciably.

Hydrofluoric acid and fluorine compounds rapidly attack the glass bond in porcelain and break down the body structure. At high temperatures, concentrated sulfuric and phosphoric acids attack porcelain. Otherwise, you can feel very free using porcelain against all acids or acid mixtures.

Steam attacks porcelain rather rapidly, so contact with steam should be avoided.

Other materials—such as metals and their alloys, plastics or rubber—are often practical for a particular process condition. Many times, however, chemical compositions

change or temperatures rise with a resulting increase in corrosion rate, or softening and deterioration of plastics and rubbers.

You don't have to be selective when using porcelain. You don't have the worry of choosing a material and then finding, or knowing beforehand, that you can't use it for another operation or set of conditions. Neither is there worry about the effect of reducing or oxidizing conditions.

Thermal Shock is Damaging

Though porcelain is fired at 2,200 to 2,400 F., this doesn't mean you can use it at such high temperatures. Temperature conditions under which porcelain operates is of the utmost importance to its service life.

Heat alone isn't very harmful to porcelain. In fact the upper use-limit might be around 700 F.—but watch out, you probably can't use it there.

Porcelain has a low heat transfer rate—between 8 and 10 Btu./(sq. ft.) (hr.) (deg. F.)/(in. thick). It just won't stand up well to abrupt temperature changes. The lower the thermal conductivity of a nonmetallic inorganic the less abuse it will take.

This low thermal conductivity of porcelain allows the outside of a porcelain pipe to feel cool to the hand for several minutes after the inside is boiling hot. This sets up tremendous differential strains, and failure results.

If it were possible to heat porcelain up slowly and uniformly, maintaining similar temperatures on both the inside and outside of the body, the practical use limit would be rather high. Since such uniform heating isn't normally practical, you should limit use to 250-300 F. There are cases where porcelain is used at uniform temperatures as high as 400 to 500 F., but great care is taken to avoid thermal shock.

As a rule-of-thumb, don't subject porcelain to a greater thermal shock than a 90 F. temperature difference. For example:

If the contents of a kettle at 250 F. are discharged into a porcelain pipeline at 70 F., you're in for trouble. You either have to cool the contents or heat the porcelain line so the transition won't be greater than 90 F.

Pay particular consideration to boiling and condensing liquids. In passing from liquid-to-vapor-to-liquid, a very severe thermal strain can be placed on the porcelain, and extra consideration must be given to avoid breakage.

Size and shape have a direct influence on the ability of a piece to withstand thermal stresses. Rectangular shapes fail faster than circular or spherical ones. Thick walls cause extreme temperature gradients that eventually result in failure. As a matter of caution, reduce by 20% the suggested maximum body-use temperature when you're using porcelain equipment with angular contours.

There is some variation in thermal shock resistance due to differences in porosity. Strong and dense porcelains are best for continuous use at higher temperatures, while low expanding, slightly porous bodies are better for more abrupt temperature changes.

Even with drastic temperature limitations on the use of porcelain and stoneware, application progress has been made. A good example is the chlorine industry. New porcelains were developed to meet the failure stresses imposed by the latest chlorine production equipment.

Not every problem has to be solved by the development of new types of porcelain. The bad name attached to porcelain and stoneware has very often come about because of poor usage practices. Each material has its own characteristics, and porcelain is no exception.

In general, you can take greater mechanical liberties with metals and plastics than with porcelain or stoneware.

You, as a chemical engineer, are probably familiar with metals and plastics and are apt to treat non-metallic inorganics as you do them. In so doing you pave the way for future troubles. Typical cases are found in plants where porcelain or stoneware piping is placed in exposed areas. Failures have occurred in sections of the southern U. S. where prevailing climate ranges from warm to hot but with sudden temperature changes.

One case is a plant where quite a run of exposed, unprotected piping was laid in a near-desert location. A rare thing for the area—a

Porcelain and Stoneware: Top-Notch Chemical Resistance

	Stoneware	Porcelain
Specific gravity	2.2-2.7	2.4-2.9
Hardness, Mohs scale	6.5	7.5
Modulus of rupture, psi	3-7,000	8-15,000
Modulus of elasticity, psi	5-10×10 ⁶	10-15×10 ⁶
Compressive strength, psi	40-60,000	60-90,000
Pore volume, %	1.5	0.2-0.5
Water absorption, %	0.5-4.0	0-0.5
Linear thermal expansion, per deg. F.	2.4×10 ⁻⁶	2.5×10 ⁻⁶
Thermal conductivity, Btu./(sq. ft.) (hr.) (deg. F.)/(in.)	8-22	8-10
Chemical resistance		
30% Sulfuric acid	no attack	no attack
95% Sulfuric acid	no attack	no attack
21% Hydrochloric acid	no attack	no attack
10% Phosphoric acid	slight attack	no attack
30% Phosphoric acid	slight attack	no attack
85% Phosphoric acid	slight attack	slight attack
10% Tartaric acid	no attack	no attack
10% Sodium carbonate	slight attack	no attack
30% Sodium carbonate	no attack	no attack
Sat. sodium carbonate	no attack	no attack
40% Hydrobromic acid	no attack	no attack
10% Sodium hydroxide	don't use above 90 F.	don't use
30% Sodium hydroxide	don't use	don't use
10% Cuprous sulfate	no attack	no attack
20% Cuprous sulfate	no attack	no attack
10% Acetic acid	no attack	no attack
30% Acetic acid	no attack	no attack
99.5% Acetic acid	no attack	no attack
10% Sodium sulfate	no attack	no attack
10% Nitric acid	no attack	no attack
30% Nitric acid	no attack	no attack
70% Nitric acid	no attack	no attack
30% Lactic acid	no attack	no attack
10% Sodium chloride	no attack	no attack
20% Sodium chloride	no attack	no attack
Sat. sodium chloride	no attack	no attack

rain squall—rode in and discharged a lot of cold water on the hot pipe. Some of the sections cracked and had to be replaced.

Another failure occurred in the northern region of the country where 24-in. pipe was set so that on sunny days the upper half was quite warm while the sheltered bottom half was below freezing. At night the entire mass had a tremendous temperature drop.

In the desert example, the difficulty could have been avoided by erecting a simple inverted V-type cover. This would protect the pipe from the direct rays of the sun, reducing the amount of heat stored.

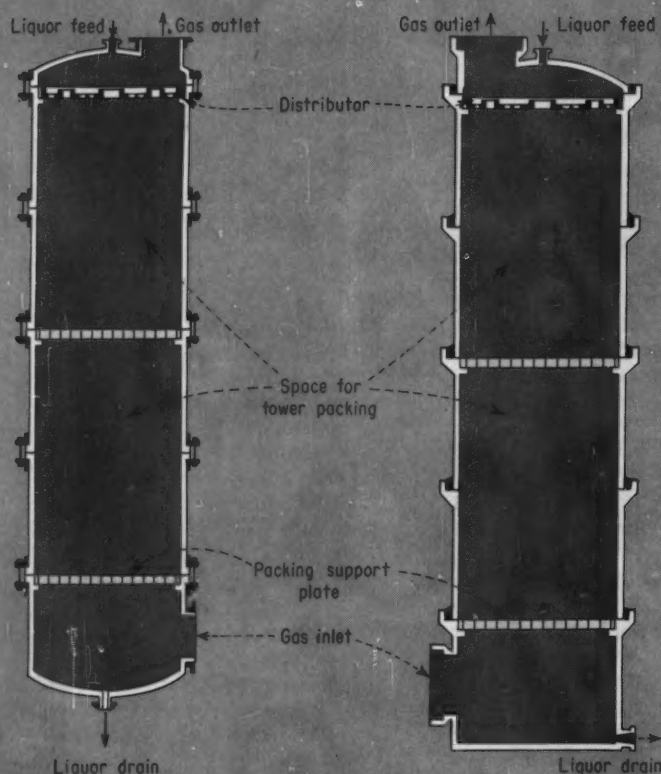
In the case of the northern climate with its greater day-to-day and seasonal temperature extremes, an insulation coating would have been invaluable. Waterproof insulation similar to that on steam lines or even a skin-type glass or other plastic-impregnated cloth coating would be all right.

How to Heat and Cool

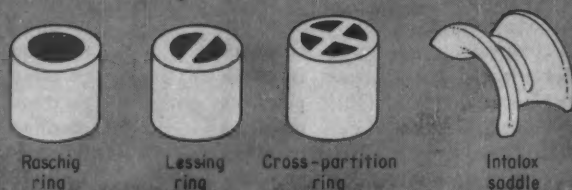
Nonmetallic inorganic materials are far superior in compression than in tension. This fact has a very practical application in thermal shock resistance.

As you heat a body, the surface goes into compression. When you

Nonmetallic Towers for Your Process



....With Packings to Fit Flow Characteristics



cool it, tensile stresses develop. Because of this, you should show greater care in cooling than in heating.

A conservative rule to follow: heat the contents of large shapes (100 gal. or more) at a rate of about 4 deg. F./min. and cool at about 2 deg. F./min.

Don't apply heat in any direct or violent manner. In other words, don't use a direct flame, open steam or localized heat source.

Resistance wire blankets, steam coils or sand baths are satisfactory methods of heating ceramics from the outside. Immersion heaters,

coils or steam diffusers are best for internal heating.

Strength Affects Service

While porcelain and stoneware have a reputation for chemical resistance, they also have the reputation for being fragile. Most engineers avoid the use of porcelain or stoneware if metals or alloys are practical.

Actually, if treated as they should be, porcelain or stoneware will give few problems from mechanical failure.

Ceramics are elastic materials, obeying Hooke's law to the point of

failure. At normal temperatures they don't elongate beyond the yield point, as many metals do. The yield point of a nonmetallic inorganic material is its failure point.

For this reason, bolting together of cemented-on-flange ceramic piping is best done with a torque wrench. When this isn't available, a 6-in. wrench, can be used if the leverage doesn't exceed 100 in.-lb.

A long wrench is apt to crack the pipe underneath the flange. Such under-the-flange failures may not become apparent until a line has been assembled and tested.

Hydraulic pressures that a line will withstand diminish as the line diameter increases. Maximum operating pressures are:

I.D.	Stoneware	Porcelain
Up to 1 in.	100 psi.	200 psi.
1 to 4	60	120
4 to 8	35	75
Above 8	20	40

These figures allow an ample safety factor and hold for flanged pipe. Bell-and-spigot pipe aren't used for high pressure work.

Maximum recommended operating pressures for porcelain Y-and angle-valves are:

I.D.	Porcelain
Up to 1½ in.	100 psi.
2	75
3 to 6	50

Unlike metals, porcelain suffers no fatigue loss of strength. You should avoid vibration, anyway, to protect joints, gaskets and bolts from loosening.

External Armor Helps Piping

A major advance in the construction and use of porcelain and stoneware has been external armors. For many years the only armor considered was iron or steel casings, into which piping was cemented with Portland or magnesia cements.

When made of polyester and epoxy resins and glass cloth or glass matting, armor is placed directly onto the surface of the nonmetallic inorganic material.

Such coatings insulate the body from the surrounding atmosphere. Heat flow, in or out, is minimized. They also give protection against mechanical impact and assure that no excessive liquid or gas escapes in the event of an accident.

Armoring such as this is becoming universally accepted and it serves as an important adjunct to

the basic material—the porcelain or stoneware.

A simpler form of good plant practice is to jacket porcelain at points vulnerable to mechanical shock. Under stairs, overhead walks, low running lines in alleys—these are all danger points. Housing porcelain within a simple wooden frame or gable affords more than enough protection for these cases.

Towers Finding Wide Use

Porcelain and stoneware towers have been in wide use for many years. But, they too get their share of criticism from the chemical engineer.

Generally, the cause of complaint is nuisance failure. Meaning—appendages stuck on the tower are often broken by the careless action of workmen or operators. Such happenings prejudice plant men against the use of these materials of construction, and they're willing to forego other advantages of the material in favor of a material that's less troublesome and difficult to maintain.

These mechanical failures have been due to the lack of change in structure design. Until recently, pieces were made to a customer's order, and drawings and designs were followed blindly. Regardless of possible consequences, the manufacturer felt he should give the customer what he wanted.

There's been a change in the attitude of manufacturers. Today, towers aren't built unless design fundamentals are adhered to and are accepted by the customer.

By avoiding disproportionately long intakes, discharge vents, cocks, bosses and other fixtures, nuisance breakage can be eliminated. By removing any temptation to support weights or improvise hand holds, sensitive appendages can't be broken off. They're designed so the casual workman can't stand on them, grab hold of them or use them in any way they weren't intended.

Greater emphasis is placed on machining. Many towers in the past failed because the purchaser wouldn't authorize grinding to be done. Then when he got his tower in the field, and assembled it, cracking occurred. This was due to uneven supporting of tower weight. If the surfaces aren't properly

smoothed and planed, they're assembled so there's point loading on them. This leads to uneven stresses concentrated at one or two points, and the tensile strength of the non-metallic inorganic body might be exceeded.

When this type of uneven construction is eliminated, and the sections are machined to fit squarely, the entire section weight is evenly distributed, and the stressing is in a compressive plane.

With the increasing use of towers, these design improvements are of the utmost importance to you, the chemical engineer seeking corrosion-proof, trouble-free operation.

You can design and have made, towers up to 4-ft. in diameter and as high as 45 ft.

Temperature limitations on these towers are somewhat dependent on the type of service. However, in contact cooling of chlorine, they handle a gas entering at 165 to 170 F. and cool the gas to 50 F.

In stripping the tower cooling water, other towers up to 30-in. in diameter are used with water entering the stripping section at 160 F., live steam entering at the bottom and the tower operating at 200 to 212 F.

In the field of high-purity, high-concentration hydrogen peroxide, these towers fill a definite need. Some of the largest hydrogen peroxide manufacturers use porcelain towers.

Acidproof Brick and Tile

When you're looking for a lining material for an acid tank or tower, an acidproof floor or any piece of equipment exposed to acidic conditions—what do you need and what do you look for?

Major properties necessary are low porosity and high resistance to corrosive action of the contacting liquids and gases. Bricks used for this service must be nonabsorbent and impervious to acids or other corrosive chemicals.

In most cases, your answer is acidproof brick or tile. These bricks are extensively used to line pickling tanks, storage tanks, towers, etc.

Most acidproof bricks are made of fireclays with a moderate degree of refractoriness. They easily fill the necessary requirements by be-

ing dense, vitreous, nonabsorbent and strongly resistant to the action of all acids except hydrofluoric. They resist most salt solutions and bases.

Operating temperatures for acid-proof brick is limited to the low to moderate range. This isn't due to the material itself, but rather, the great difficulty in maintaining tight joints at high temperatures and the generally poor thermal shock resistance of the brick. Poor resistance to thermal shock is one of their chief drawbacks.

Mortars Are Permeable

Along with thermal shock resistance, the need to bind the brick together with a mortar is a key disadvantage to using these materials. Not only is the structure dependent on the properties of the brick, but also of the mortar. In general, the cements used to set and lay acid-proof bricks are brittle, have limited resistance to temperature and oxidizing conditions, and they're permeable.

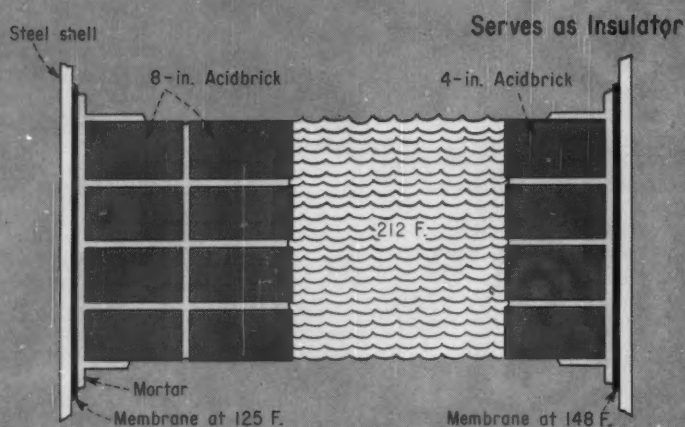
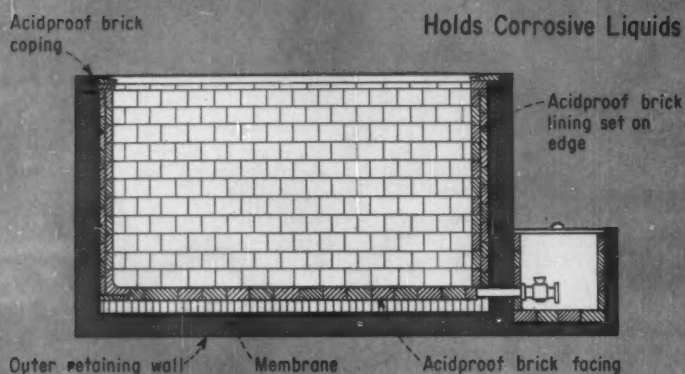
When acidproof brick is only for low-temperature service, sulfur or organic cements will do well for the mortar. When higher operating temperatures are called for, silicate cements can be used. Not only do silicate cements stand up to the temperature better, but they also resist the increased corrosiveness of hot acids.

Because mortars, used to bind the brick into massive structures, are permeable, an impervious lining or membrane behind the brick is necessary. These membranes must withstand the action of the acid and contain the entire contents of the tank. They are made of acid-resisting organics like Tygon or metals like lead.

Thermal insulating value of acid-proof brick and tile is rather high. When used to line a tank, they effect a high temperature-drop from a tank interior to the outside, as shown in the illustration on the next page. It's because of the insulating value of the bricks that impermeable membranes can be used in many applications. Otherwise, the membranes couldn't stand up to direct contact with the corrosives at the temperatures in the tank.

When you're using a lining behind acidproof brick, you must make accommodation for the ther-

Double Duty for Acidproof Brick:



mal expansion of the brick. Of course this isn't necessary if you use anchored concrete linings that don't need impermeable membranes. These concrete linings, as mentioned earlier, withstand temperatures of 900 F. in refinery reactors and distillation towers.

Cellular Glass and Silica

Cellular glass is used as pre-formed block, 2- or 3-in. thick. Its application in the chemical industry for protection against corrosion is limited because of poor structural properties. As thermal insulation it's found some use.

Blocks must be jointed using either organic or silicate cements. Because the cements are porous, you must use an impermeable barrier behind it; construction is similar to that used with acidproof brick.

Thermal shock and large static thermal gradients must be avoided, and special construction is necessary if vibration is present.

Cellular silica, a new product manufactured by the same firm that makes cellular glass, has better physical properties in almost every respect. Only when you consider the thermal conductivity of cellular silica does the glass match it.

This new material is relatively refractory with a use-limit up to 2,200 F. and extremely low thermal expansion.

An effective cement is available for jointing made of ground cellular silica and silica hydrosol. Like the cements for jointing cellular glass and acidproof brick, this special mortar is porous and requires the use of an impermeable membrane for protective back-up.

This is unfortunate, since one of the outstanding properties of cellular silica is its lack of permeability. Being completely impermeable to the passage of gases or liquids, this material can be used for any type of liquid or gaseous service that won't attack it.

Cellular silica has a bright future in acid-resistant construction. Because of its low thermal conductivity and excellent thermal shock resistance it should replace acidproof brick to a large extent.

Some very active acids, such as hot concentrated phosphoric, may attack it, and bases are very active against it. It won't resist heavy impact or abrasion but for many uses you'll find it superior to acidproof brick.

Glass for Processing

Glass has some pretty specific advantages when it comes to chemical processing:

- High degree of corrosion resistance.
- Moderate operating temperatures allowable.
- Noncontaminating.
- Transparent.

There's almost an infinite variety of glass formulations, each available for specific applications. As a chemical engineer, you only need a working knowledge of the most commonly used glass construction materials for chemical processing.

Soda-lime—Economical to melt, fabricate and use. When its properties are applicable, soda-lime glasses are the cheapest and easiest to work with. For process work, unfortunately, their properties are less suitable than other materials.

Borosilicate—Exhibiting low coefficients of expansion and extremely high chemical resistance, these glasses are the workhorses of the chemical industry. Most glass processing equipment in use today,

whether it be piping or a reactor lining, is made from borosilicate glasses.

Fused silica—Extremely high purity and thermal shock resistance allow a wide variety of applications for fused silica.

96% Silica—Many of its properties are similar to fused silica. For a glass, it has almost amazing thermal properties and a very high degree of chemical resistance.

Pyroceram—While not truly a glass it merits inclusion with the glasses. This material is a dense, nonporous, crystalline material manufactured from a noncrystalline glass. Its strength properties almost approach the metals.

Corrosives—Little Effect

Almost all glasses are outstanding in their ability to withstand chemical attack. All of the above-mentioned glasses are measurably affected only by hydrofluoric acid, hot concentrated phosphoric acid, alkaline solutions and superheated steam. When selecting glass for chemical resistance, your best answers are found with borosilicate and high-silica glasses.

Superheated water—above 300 F.—attacks glass but even here, the attack isn't great enough to dictate against your using it in applications that call for direct contact. Generally, the rate of attack by hot water is governed by the alkalinity of the water.

Soda-lime glasses are your poorest approach to the problem of chemical resistance, while Pyroceram falls just below the highly resistant borosilicate glasses in durability.

Sulfuric, hydrochloric, nitric and acetic acids, and other materials such as chlorinated hydrocarbons, hydrogen peroxide, bromine and brines are adequately handled by the borosilicate, or high-silica glasses.

Operating Temperatures: Moderate

Heat resistance of most glasses allow operation at a moderately high temperature-level.

You can normally use borosilicate glasses up to 250 F. In this range you don't need unusual precautions. Operating temperatures can go as high as 450 F., if you make sure there won't be any sudden temperature changes. Insulation over the

pipe is the usual way of doing this. There are some special cases where borosilicate glasses have been used above 450F. but these are rare.

Sudden temperature differential is the main cause of thermal loss of borosilicate glass equipment. Nevertheless, it's withstood temperature changes as severe as those caused by a low-pressure steam purge followed by a cold liquid.

The following recommends the maximum temperature differential for borosilicate piping:

Dia., In.	Temp. Diff., Deg. F.
1	200
1½	200
2	200
3	200
4	175
6	160

This maximum difference is for an instantaneous change in temperature. If you're going to exceed this, use as a guide: a uniform difference of 100 deg. F./min. is safe for any size borosilicate piping.

Soda-lime glasses, because of their high thermal expansion, have very poor resistance to heat shock. In fact, avoid any rapid temperature differential with a soda-lime glass.

Fused silica has such a low coefficient of expansion, 3.2×10^{-7} /deg. F. (67–608 F.), that it withstands severe thermal shock. This material can be operated, under some conditions, at temperatures as high as 1,800 to 2,000 F.

Most important property of 96% silica glass is its ability to with-

stand operating temperatures as high as 1,650 F. and severe thermal shock. Red-hot crucibles of this material have been plunged into ice water without damage. In a large way, this is due to its low thermal expansion.

Pyroceram, as mentioned earlier isn't really a glass but rather a crystalline material manufactured from a glass. Thermal shock resistance of this new crystalline material is greater than dense alumina and about equal to fused silica. Some Pyrocerams keep their strength as high as 2,375 F.

Limit to Mechanical Strength

Whenever you're working with glass, remember—it can break. Intrinsicly, glass has an extremely high tensile strength. However, the actual strength is dependent on surface conditions and varies a great deal. Mechanical properties of glass are given in the table of glass properties.

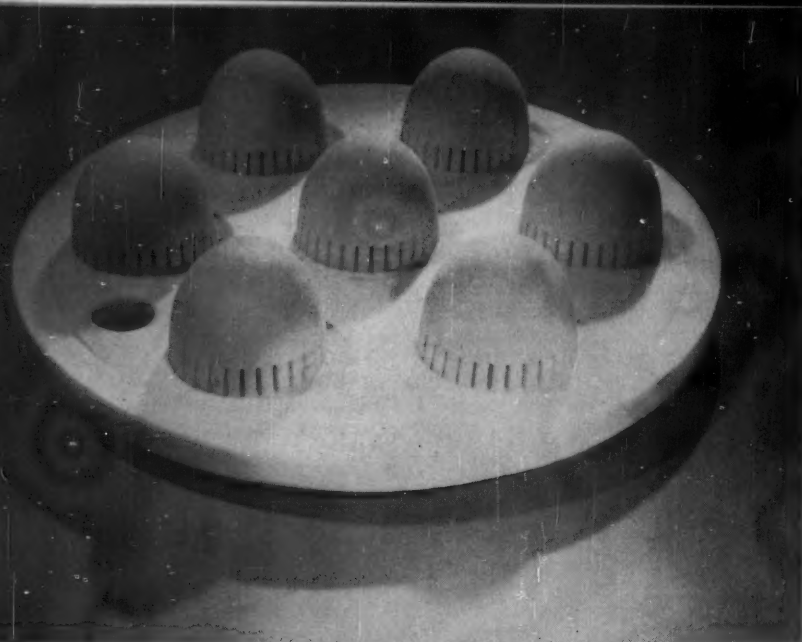
Mechanical hardness of glass is rather high. In general, glass is resistant to erosion. Of course, when the mechanical hardness of glass is compared to materials such as porcelain or alumina, it falls short of their abrasion resistance.

Maximum operating pressures of borosilicate piping are as follows:

Dia., In.	Pressure, Psi.
1	50
1½	50
2	50
3	50
4	35
6	20

Glass Offers a Variety of Properties

	Pyroceram	96 % Silica	Boro-silicate
Specific gravity, 77F.....	2.60	2.18	2.23
Water absorption, %.....	0.00	0.00	0.00
Gas permeability.....	gas tight	gas tight	gas tight
Softening temp., deg. F.....	2,282	2,732	1,508
Specific heat, 77F.....	0.185	0.178	0.186
Mean specific heat, (77–752F.).....	0.230	0.224	0.233
Thermal conductivity, mean temp. 77F., Btu./sq. ft. (hr.) (deg. F.)/(in.) ...	25.2	7.5
Linear thermal expansion, per deg. F., (77–572F.).....	32×10^{-7}	4.4×10^{-7}	18×10^{-7}
Modulus of elasticity, psi. $\times 10^{-6}$	17.3	9.6	9.5
Poisson's ratio.....	0.245	0.17	0.20
Modulus of rupture, psi. $\times 10^{-3}$	20	5–9	6–10
Knoop hardness, 100 g.....	698	532	481
Knoop hardness, 500 g.....	619	477	442



Bubble cap made of 96% silica for corrosive conditions (Corning Glass Works)

In special cases, the maximum pressure can be increased to 125 psi. for 1-in. pipe, 80 psi. for 1.5-in. pipe and 70 psi. for 2-in. pipe.

The important point to keep in mind is: equipment made of glass should be treated as if it were made of glass. This requires special defence and training, but once the initial understanding is obtained, glass equipment is relatively free of problems.

Applications Galore

Possible process applications for glass and glass equipment are as wide as your imagination. There are many standard items available directly from manufacturers.

Heat exchangers come in a variety of sizes and types. Heat exchange area of 50 sq. ft. is obtainable from shell and tube exchangers using borosilicate piping. For very high-temperature operation you can use exchangers made of fused silica.

Glass columns are made up to 24-in. diameter. Tower internals, including the bubble cap shown in the accompanying illustration, can be had in a variety of glasses.

Centrifugal pumps made of glass are excellent for handling acids and other corrosive chemicals. Capacities are from 15 gpm. with a 30-ft. head to 115 gpm. with a 60-ft. head.

Glass is a unique engineering material in that, with only a few exceptions, all forming and fabricating is done by the glass producer. In most cases, the producer does all the design work for you and stock

items are the most economical and easily available.

However, glass is a material that has wide freedom with shape design and form. There's a lot of leeway as to the shapes glass can be put into. Just remember as a designer and engineer, the cost of custom glass-process-equipment can be excessive. Glass costs are relatively low when compared to fabrication.

For this reason, it's best to stay with standard design items. For custom designs, compare the cost of other competing materials, such as porcelain, against the properties you need. You must balance the particular material's properties against its cost. It's sometimes better engineering and less costly to take a poorer material, even with frequent replacements, than to use an excessively high-priced material.

Glass-Lined Steel

Glass-lined steel is a basic material of construction for the chemical process industries. It's the glass used—a special borosilicate formulation—that gives the composite body its unique properties.

There's a wide variety of equipment available and ready for process use. Reactors, columns, storage tanks, piping, valves and pumps are just a few of the stock items of equipment purchasable.

An even larger variety of custom equipment is available from individual manufacturers. In all cases, the installation of the glass lining is done by the manufacturer;

Properties of Glass Linings

Physical properties

Specific gravity . . .	2.56
Modulus of elasticity, psi	$6-9 \times 10^6$
Moh hardness	6
Adhesion strength, psi	5-10,000

Chemical resistance

Organic acids	all
Inorganic acids	all except HF
Alkalis	up to pH of 12 at 210 F.

Thermal Properties

Thermal expan., per deg. F.	$50-208 \times 10^{-7}$
Max. operating temp., deg. F.	500*
Thermal shock resistance, temp. difference, deg. F.	305

*Special glasses operate as high as 1,500 F.

metal fabrication is also his responsibility.

Resists Almost All Corrosives

When you talk about the corrosion resistance of glass-lined equipment you have to reorientate yourself into a new line of thinking. Most materials corrode away at a perceptible rate. Glassed steel, on the other hand, below certain temperatures is practically unaffected by corrosives.

It's true there's some attack on the glass, but for all practical purposes, you can consider it nonexistent. In general, glass coatings—up to 0.030-in. thick—resist all common acids except hydrofluoric and in some cases phosphoric.

Ultimate acid resistance is limited by an upper temperature limit between 300 and 325 F. Above this range, the rate of attack increases and individual service conditions dictate your use of the material. For example, glassed steel resists concentrated sulfuric acid up to 450 F.

With alkaline conditions there's another problem. Like most silicate materials, glassed steel is attacked by bases. Nevertheless, you can safely use this material at a pH of 12 up to 210 F.

Hot water corrodes most engi-

neering materials and even some acid-resistant glass linings. However, there are special glass formulations available for coating on steel. These will resist all types of water in all geographic locations.

Mechanical Factors Affect Use

Let's start off by saying glass-lined steel equipment can be damaged. Impact will chip it. But, unlike most glassy materials, fractures don't run. Sharp mechanical impact causes damage only at the point of impact.

Strains below the elastic limit of the metal substrate, don't ordinarily affect the glass lining. The point here is, you're working with glass and not metal. Equipment made of this composite must be treated a little differently.

You can patch glass-lined equipment if damage occurs, with one of several techniques for effective on-the-spot repairs. Type of repair is determined by nature of the damage and the service of the equipment.

Field patching, using tantalum or noble metal plugs, silicate cements, or thermosetting (usually epoxy or epoxy-phenolic) catalyzed resins, is your best approach.

Many applications for glass-lined equipment exist at elevated temperatures—for example, jacketed

reactors heated by high-pressure steam or Dowtherm. Here, nonuniform heating of improperly designed nozzles may cause residual stresses on cooling. Result—local loss of the glass coating.

Thermal shock, in general, can be dangerous. Like most of the non-metallic inorganic materials of construction, you should heat and cool glass-lined steel with caution. Glass linings withstand heating rates of 150 deg. F./min.

Size Limits Application

Although there's a wide variety of glass-lined equipment available, there are some limitations as to size. How large is glassed steel equipment? Check the following list:

- *Reactors*—From 5 to 8,000 gal.
- *Columns*—Any length with diameters up to 13 ft.
- *Storage tanks*—From 750 to 35,000 gal.
- *Dryer-blenders*—Up to 255 cu. ft.
- *Heat exchangers*—Up to 316 sq. ft.

From this listing you've a fair idea of the size limitations on glass-lined equipment. These limitations are due to a variety of factors—from thickness of the base metal to imparting of thermal stresses.

Porcelain Enamels

Glassy-type coatings are known under a variety of names—porcelain enamels, vitreous coatings or just plain enamels. They are thin coatings of glass applied to a metal.

Porcelain enamels differ from glass linings mentioned previously only by being less resistant to chemical attack. In fact, consider glassed steel as a special case of a porcelain enamel.

With porcelain enamels you have available an amazing variation in properties. By changing the nature and thickness of the base metal or the composition of the coating, any combination of strength, corrosion resistance, oxidation resistance, refractoriness, hardness or surface smoothness is obtainable.

Chemical Resistance Rivals Glass

Porcelain enamels are glasses. Still, most commercially available enamels or enameled parts only approximate the chemical durability of glass—they don't equal it.

Thermal expansion of the glassy coating and the substrate must be compatible (match) . . . a prime requisite for adherence. Necessarily, some other properties must be sacrificed to this end; chemical resistance is one of them.

Enamels must be fired at a sub-

Select Nonmetallic Inorganic Coatings From this Table

Coating	Base			Use		Functions
	Organic	Metallic	Ceramic	Protection	Synergism*	
Vitreous silicates. . . .	no	yes	yes	yes	yes	Resist corrosion, wear, heat.
Crystalline silicates. . .	yes	yes	yes	yes	no	Resist molten metal, heat, electric potential.
Silica.	no	yes	yes	yes	yes	Resist oxidation, electric potential.
Silicides.	no	yes	yes	yes	no	Resist oxidation, erosion, wear.
Suboxides.	no	no	yes	no	yes	Resist erosion; catalysts; electrically conductive.
Oxides.	no	yes	yes	yes	yes	Resist heat, wear, impact, molten metal; catalysts.
Carbides, borides. . . .	no	yes	yes	yes	no	Resist wear, heat.
Sulfides.	yes	yes	yes	no	yes	Photoemissive.
Phosphates.	no	yes	no	yes	no	Resist corrosion; primer coatings.
Titanates.	no	yes	no	no	yes	Capacitor layers; piezoelectrics.
Ferrites.	yes	no	yes	no	yes	Semiconductors.
Graphite.	yes	no	yes	yes	yes	Resistors; printing systems; anti-friction coatings.

* Total effect of base plus coating is better than the sum of each taken alone.

stantial temperature for a bond to develop between the coating and the metal, and there's a limit to how high you can heat the base metal. The most chemically resistant glasses require the highest firing temperature.

Unfortunately, lower-priced metals and alloys can't be subjected to high temperatures for any length of time. You must balance out the increased cost of using higher-priced alloys against your requirements for chemical durability.

All this, together with the exceedingly thin coating—usually less than 0.015 in.—decreases the possibility of outstanding corrosion resistance. There are many enamels with chemical durability that rival glassed steel, but these are special formulations and generally call for a sacrifice of some other vital property.

Thermal Properties Are Boosted

In most cases, the thermal properties of the metal substrate is boosted to withstand the service conditions. Temperature resistance for porcelain enamels fall into two categories: refractoriness and thermal shock.

Standard porcelain enamels can be used up to 800-1,000 F. From

1,000-1,200 F., the enamel may be damaged but the substrate metal is still protected. You need special refractory coatings for work above 1,200 F.

Temperature drops of 200 deg. F. are allowable with most porcelain enamels without damage to them. In some cases with a few enamels, thermal shock as severe as cyclic heating to 350 F. with ice water quenching is possible without damage.

In general, resistance to thermal shock is in the poor-to-fair range. Of course, some enamels exhibit excellent resistance but these are rare. Variables that play a part here are the thinness of the coating and the compatibility of the thermal expansions of base and coating materials.

Coatings for High Temperature

While not falling under the category of porcelain enamels, refractory coatings are similar in many ways and deserve coverage in this section.

These coatings are thin nonmetallic inorganic layers—usually 0.005-in. thick—on a metallic base. They've found extensive use in corrosion protection of alloys such as the 300-series stainless steels.

As a stand-out performer against oxidation, refractory coatings have worked their way into the chemical plant. They've been applied to thermowelds, small pipe-type reactors and furnace parts.

Coatings of this type are very refractory and may be used for continuous protection against oxidation as high as 1,700 F. and for moderate time durations up to 2,150 F. Unfortunately, these coatings, in the presence of hydrogen, are subject to blistering at temperatures between 500 and 1,000 F.

You can apply a refractory coating in the field by spraying or drain-coating, followed by closely controlled heating to 1,600 to 1,750 F. Most commonly, they're shop-applied. In some cases you can field patch these coatings—a decided advantage. Patching is done by brush or spray application followed by heating with an oxy-gas or oxy-acetylene torch.

Flame-Sprayed Coatings

In their present state of development, flame-sprayed oxides don't

seem to be particularly useful for protection against liquid corrosives. Porosity is appreciable and thickness of a coating necessary to lower the porosity is excessive. Thick coats reduce the thermal and mechanical shock resistance of the coating.

However, this varies with the coating, the method of application (at least three commercial processes exist) and the substrate. In fact, it's possible to seal these coatings by impregnating them with resins (phenolic or silicone) or alkali silicates. This improves their ability to protect the metal base under the right conditions.

On the other side of the picture, flame-sprayed coatings are quite effective in reducing the rate of oxidation of ferrous alloys. They're probably just as effective in other gaseous environments.

They can be either shop- or field-applied, and field-patching is possible.

When either space limitations or wear conditions are present, flame-sprayed coatings may be your best choice for corrosion protection.

In acknowledgement, the author wishes to particularly thank Walter Perkins, U. S. Stoneware; Jim Wygant, Standard Oil of Indiana; and also Armour Research Foundation, Battelle Memorial Institute, Carborundum Co., Lapp Insulator Co., Inc. and the Pfadler Co.



MARTIN D. ROBBINS is an assistant editor on Chemical Engineering. Behind this staff-written report on materials selection stands several years of background experience: he holds a BS in chemistry from Tufts and an MS in ceramics from M.I.T. Before joining the staff of CE Robbins was with DuPont as a chemical engineer where his work involved high-temperature processes and materials selection.

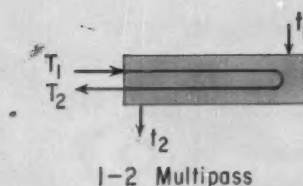
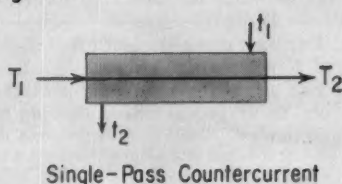
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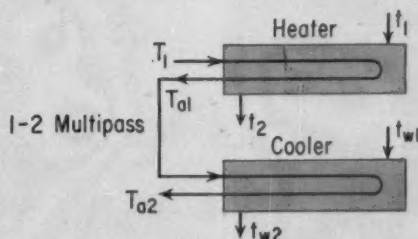
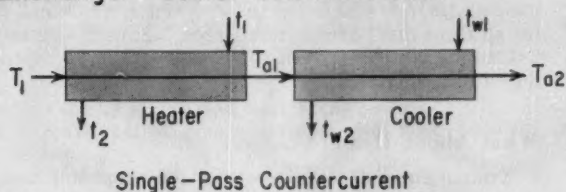
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AND in December, watch for High-Temperature Metals. This big biennial Report on Materials of Construction will wind up the comprehensive series.

Simple Exchangers



Exchanger-Cooler Combinations



Novel, handy equations give you optimum heat exchanger design easily and quickly in terms of terminal temperatures.

Easy Way to Optimum Exchangers

JOHN HAPPEL, Chairman, Dept. of Chemical Engineering, New York University, New York, N. Y.*

Tubular heat exchangers are a major expense item in most chemical processes. To keep costs as low as possible you should design such exchangers to operate at some economic optimum point.

For heat exchangers where heat otherwise wasted is saved, the economic balance is based on the optimum terminal temperatures (and consequent amount of heat transferred) which will result in maximum savings. This is the problem we will consider in the following derivations.¹

It is assumed that tube dimensions are specified. While theoretically an economic balance should involve calculation of optimum pressure drop, in practice an allowable pressure drop is generally specified.

Also the designer, for preliminary calculations, can usually select an over-all heat transfer coefficient which is substantially independent of area.^{2, 3}

In studies of this kind it is not necessary to know total costs.⁴ Incremental costs per sq.ft. of exchanger or cooler surface should be employed.

How to Calculate Optimum Earnings

Let's start with the simplest case, where the medium on one side does not change temperature (such as a steam preheater, reboiler or waste heat boiler). Consider a device where a medium at constant temperature T is heating a fluid which does not vaporize from temperature t_1 to temperature t_2 . The operating earnings, O , in \$/yr. above the minimum acceptable rate as specified in terms of payout time will be

$$O = \underbrace{\frac{Q H_t Y 8770}{1,000,000}}_{\text{value of heat recovered}} - \underbrace{r E A + r C_t}_{\text{cost of recovery}} \quad (1)$$

The optimum will be determined by expressing all variables in terms of a single one, differentiating and setting the derivative equal to zero. In this case A will be selected as the independent variable. Before differentiation it is then necessary to express Q in terms of A . This is accomplished by a heat balance and the heat transfer equation.

$$\text{then } \frac{dO}{dA} = \frac{U (T - t_1) H_t Y 8770}{1,000,000} - r E \quad (2)$$

Note that the constant C_t disappears in differentiation. In subsequent derivations here it will be omitted. If dO/dA is set equal to zero,

$$(T - t_2)_{\text{opt}} = 114 r E / U Y H_t = H / H_t \quad (3)$$

where H is defined equal to $114 r E / U Y$.

The same result can be more simply obtained by using t_2 as the independent variable.⁴ Note that where one fluid does not change in temperature, the equivalent temperature difference for each incremental square foot is equal to the terminal temperature difference.

Countercurrent and Multipass Design

You can still use Eq. (1) where temperatures of both fluids change. In this case for countercurrent flow

$$[(1 - P)(1 - RP)]_{\text{opt}} = H / H_t D \quad (4)$$

where $D = T_1 - t_1$ or difference in entering tempera-

* To meet your author see *Chem. Eng.*, July 14, 1958, p. 177.

Equations for Optimum Terminal Temperatures

Simple exchanger...

Where one medium does not change temperature:

$$(T_1 - t_2)_{\text{Opt}} = \frac{11.4rE}{UYH_1} = \frac{H}{H_1}$$

Where flow is countercurrent:

$$[(1-P)(1-RP)]_{\text{Opt}} = \frac{H}{H_1 D}$$

Where design is 1-2 multipass:

$$[1-P(1+R-\frac{RP}{2})]_{\text{Opt}} = \frac{H}{H_1 D}$$

Exchanger-cooler combination...

Where flow is countercurrent:

$$[(1-P)(1-RP)]_{\text{Opt}} = \frac{H}{H_1 D}$$

Where flow is 1-2 multipass:

$$[1-P(1+R-\frac{RP}{2})]_{\text{Opt}} = \frac{H}{H_1 D}$$

In this case you must take the effect of the cooler into account. See text for calculation of heater-cooler H_1 .

ture between hot and cold fluids; $R = WC/wc$; $P = (T_1 - T_2)/(T_1 - t_1)$.

For any given problem $H/(H_1 D)$ will be a constant and R will be fixed.

For a multipass exchanger of the 1-2 type, it is possible to arrive at the following relationship for the optimum^a

$$[1 - P(1 + R - RP/2)]_{\text{opt}} = H/H_1 D \quad (5)$$

For multipass exchangers of the (2-4) type, graphical differentiation is most convenient for the evaluation of P . Ten Broeck^a has presented a convenient nomograph for evaluation of P , given $H/H_1 D$ and R for all three cases of countercurrent, 1-2 multipass and 2-4 multipass exchangers. This nomograph is reproduced here.

What About Heater-Coolers?

Evaluation of H_1 , the total cost of supplying heat, may present complications. It is composed of several elements. First there will be a saving resulting from decreased fuel consumption. Value of the heat saved can be determined from the price of the fuel, its heating value and the expected furnace efficiency. Cost of supplying heat by a furnace will include the fixed charges on incremental cost of furnace in addition to the incremental fuel cost.

Also, the heat transferred to a stream being heated often represents a saving in cooling requirement. In addition to the saving in cooling water, fixed charges on the incremental cooling equipment must also be taken into consideration. Since individual coolers are employed to bring hot streams to storage temperature, the design of these coolers may be substantially affected by the degree of cooling accomplished in corresponding exchangers. Methods for determining the effect of coolers in conjunction with exchangers are detailed in the following discussion.

The diagrams show a typical exchanger-cooler combination. In this case a hot stream at temperature T_1 is cooled to T_{s1} in preheating a cold stream from temperature t_1 to t_2 . The temperature T_{s1} is still above the desired storage temperature and the original stream is cooled from T_{s1} to T_{s2} in a cooler with water which rises in temperature from t_{w1} to t_{w2} .

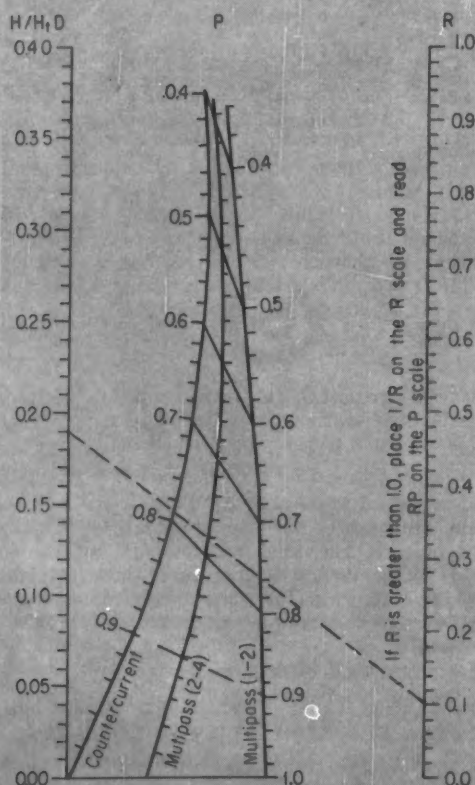
Our previous derivation was based on given quantities of hot and cold fluids and given inlet temperatures. Its object was to specify the outlet temperatures of both fluids. The problem now is still essentially to specify t_2 and T_{s2} . However, it is assumed that cooling cost items will enter the picture as auxiliary dependent variables. If the cooling water temperature t_{w1} is specified and the rise in temperature is fixed, t_{w2} will be specified. It is assumed that T_{s2} , the temperature of the cooled stream to storage, is also fixed.

Set Up Basic Optimum Equations

The problem can be set up as a function of one independent variable as previously. The following derivation following Ten Broek^a may be applied:

The operating earnings, O_e , will be equal to (the value of heat recovered) - (cost of cooling) - (heat exchanger surface cost) - (cooler cost) + (cost of cooling water in the absence of heat exchanger) + (cost of cooling surface in the absence of heat exchanger).

Use Nomograph to Find Fractional Approach, P



Nomenclature

A	Heat exchange surface, sq.ft.
A_1	Heat exchanger surface, sq.ft.
A_c	Cooler exchanger surface, sq.ft.
A'_c	Cooler surface in absence of exchanger, sq.ft.
C_i	Constant cost of an installation, \$(Total = $C_i + EA$).
C	Specific heat of hot fluid.
c	Specific heat of cold fluid.
D	Entering temperature difference, $T_1 - t_1$, F.
E	Incremental surface cost, \$/sq.ft.
E_1	Incremental exchanger surface cost, \$/sq.ft.
E_c	Incremental cooler surface cost, \$/sq.ft.
H	$114rE/UY$
H_1	$114rE_1/UY$
H_c	$114rE_c/UY$
H_i	Value of incremental heat, \$/million Btu.
H_1	Total cost of supplying incremental heat, \$/million Btu.

H_{w1}	Value of cooling water, \$/million Btu.
m	Maintenance and repair allowance, fraction/yr.
P	Fractional approach, $(T_1 - T_2)/(T_1 - t_1)$.
Q	Heat transfer rate, Btu./hr.
Q_1	Heat transferred in heat exchanger, Btu./hr.
Q_c	Heat transferred in cooler, Btu./hr.
r	Fraction of total annual charges on the cost of a sq.ft. of surface to allow for maintenance, depreciation and minimum acceptable profit ($= m + 1/T_m$).
R	WC/wc
T_m	Max. allowable payout time before taxes and depreciation, yr.
U	Over-all heat transfer coefficient, Btu./hr. (sq.ft.) (F).
W	Flow rate of hot fluid, lb./hr.
w	Flow rate of cold fluid, lb./hr.
Y	Fraction of year equipment will be in operation.

$$O_1 = \frac{Q_1 H_i Y 8770}{1,000,000} - \frac{Q_c H_{w1} Y 8770}{1,000,000} - r E_1 A_1 - r E_c A_c + \frac{(Q_1 + Q_c) H_{w1} Y 8770}{1,000,000} + r E_c A'_c \quad (6)$$

Know What to Include in Calculations

Note that H_i includes fixed charges on furnace equipment; but this item is usually not dependent to any extent on the temperature to which the exchanging streams are preheated. Heat transfer in a furnace occurs at a sufficiently high temperature so that small differences in temperature of streams being heated will not effect the economics of heat transfer. Also E_1 and E_c should include costs of installation as well as delivered cost of equipment. Thus we can derive the following:

$$\left[\frac{dQ_1}{U_1 dA_1} \right]_{opt} = \frac{H_1}{H_i + H_{w1}} + \frac{H_c}{dQ_c/(U_c dA_c)} = \frac{H_1}{H_i} \quad (7)$$

where, H_1 is defined as $114 r E_1/UY$ and H_c is $114 r E_c/UY$.

It can readily be shown that $H_1/H_i = [D(1 - P)(1 - RP)]_{opt}$, and $H_c/H_i = [D - DP(1 + R - RP/2)]_{opt}$ for countercurrent and 1-2 multipass exchangers respectively.

The only new element involved is the evaluation of H_i which now includes H_1 , H_{w1} and $H_c/(dQ_c/U_c dA_c)$. The latter item is equal to the following for countercurrent flow in the cooler:

$$\frac{dQ_c}{U_c dA_c} = \frac{\Delta t_1 - \Delta t_2}{\ln \frac{\Delta t_1}{\Delta t_2} \left(1 - \frac{T_{a1} - T_{a2}}{\Delta t_1 - \Delta t_2} \right) + \frac{T_{a1} - T_{a2}}{\Delta t_1}} \quad (8)$$

where $\Delta t_1 = T_{a1} - t_{w1}$; $\Delta t_2 = T_{a2} - t_{w2}$.

When $t_{w1} = t_{w2}$, corresponding to an unlimited supply of cheap cooling water,

$$\Delta t_1 = dQ_c/(U_c dA_c) \quad (9)$$

This assumption was made by Ten Broeck³ in his derivation, though in general, as he notes, a rise to 100-125 F. is usually allowable.

A similar derivation for the case of a cooler having 1-2 multipass flow gives the following for calculating cooler fixed charges:

$$\frac{dQ_c}{U_c dA_c} = 1 \left[\frac{1}{\gamma} \left(\ln \frac{\beta + \gamma}{\beta - \gamma} \right) \left(1 - \frac{Q_c^2}{W^2 C^2 \gamma^2} \right) - \left(\frac{2Q_c}{WC} \right) \left(\frac{1}{\beta^2 - \gamma^2} \right) \left(1 - \frac{Q_c}{WC \gamma^2} \right) \right] \quad (10)$$

where,

$$\beta = 2 T_{a2} + \frac{Q_c}{WC} - t_{w1} - t_{w2}$$

$$\gamma = \left[\left(\frac{Q_c}{WC} \right)^2 + (t_{w1} - t_{w2})^2 \right]^{1/2}$$

$$Q_c = WC (T_{a1} - T_{a2})$$

To employ (8) or (10) in conjunction with Eq. (7), it is necessary to use a trial and error solution in which T_{a1} must be assumed to compute $dQ_c/(U_c dA_c)$.

More complicated cases may be encountered in practice where additional hot and cold streams are involved in the same process unit. Ten Broeck and Whistler have attempted solutions of such situations.^{3,4}

Some Hints and Conclusions

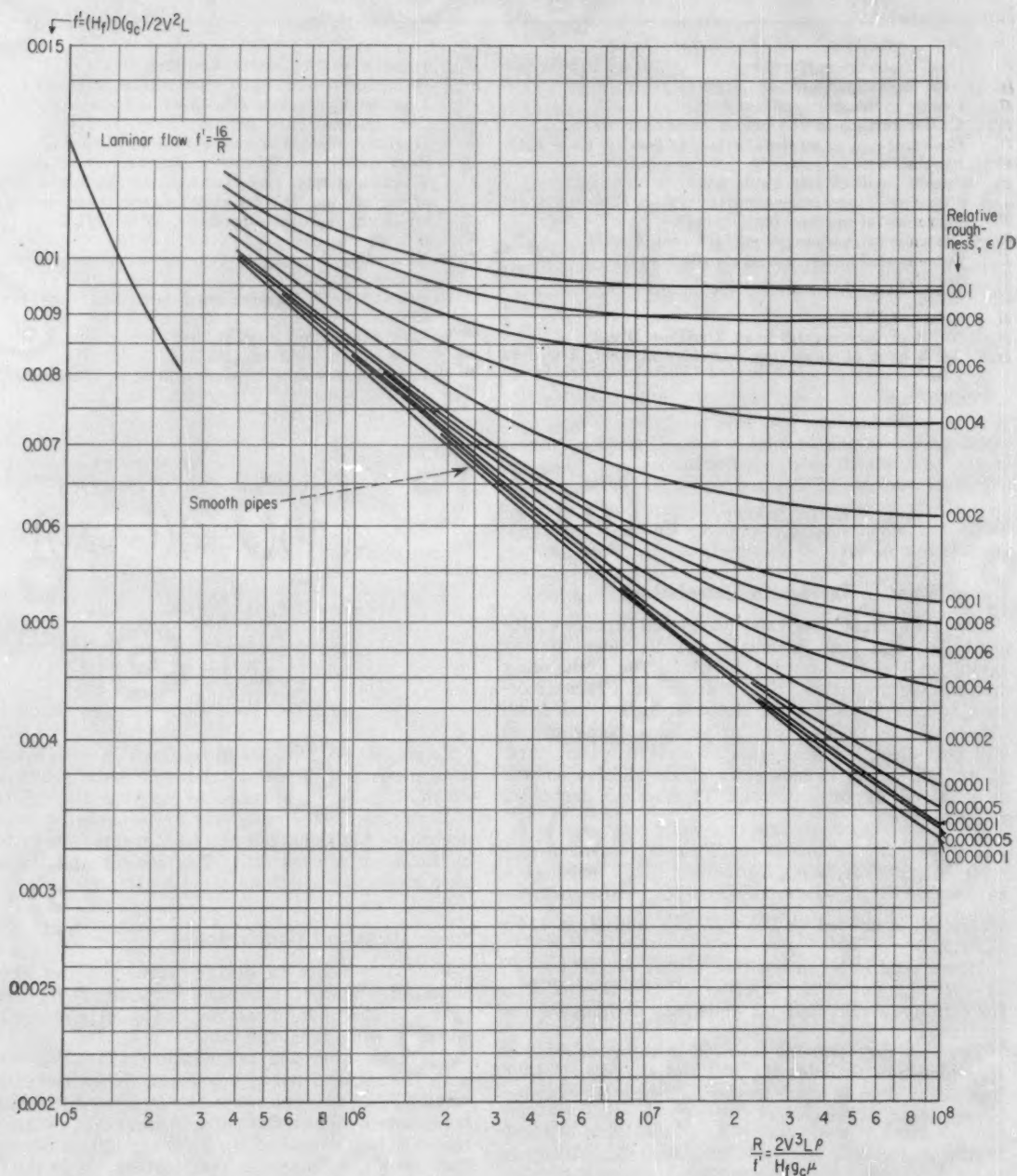
For convenience in design work, you can develop tables of optimum approach temperature⁵ for various values of R and D . Then you can quickly pick out an optimum value from the table.

Optimum approach temperature ($T_1 - t_2$) varies with the ratio of hot to cold fluid. When the ratio is small ($T_1 - t_2$) comes close to D , since little heat is transferred. When the ratio is large ($T_1 - t_2$) corresponds to the value of H_1/H_i , the condition where one fluid does not change in temperature. It is thus not possible to employ simple correction factors over a wide range of hot to cold fluid ratios.

In general the effect of changes in maximum acceptable payout time are small because furnace charges tend to counterbalance exchanger fixed charges.

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Speed Trial and Error Solution

J. P. TASSONEY and J. M. DROTTER, University of Pittsburgh, Pittsburgh, Pa.

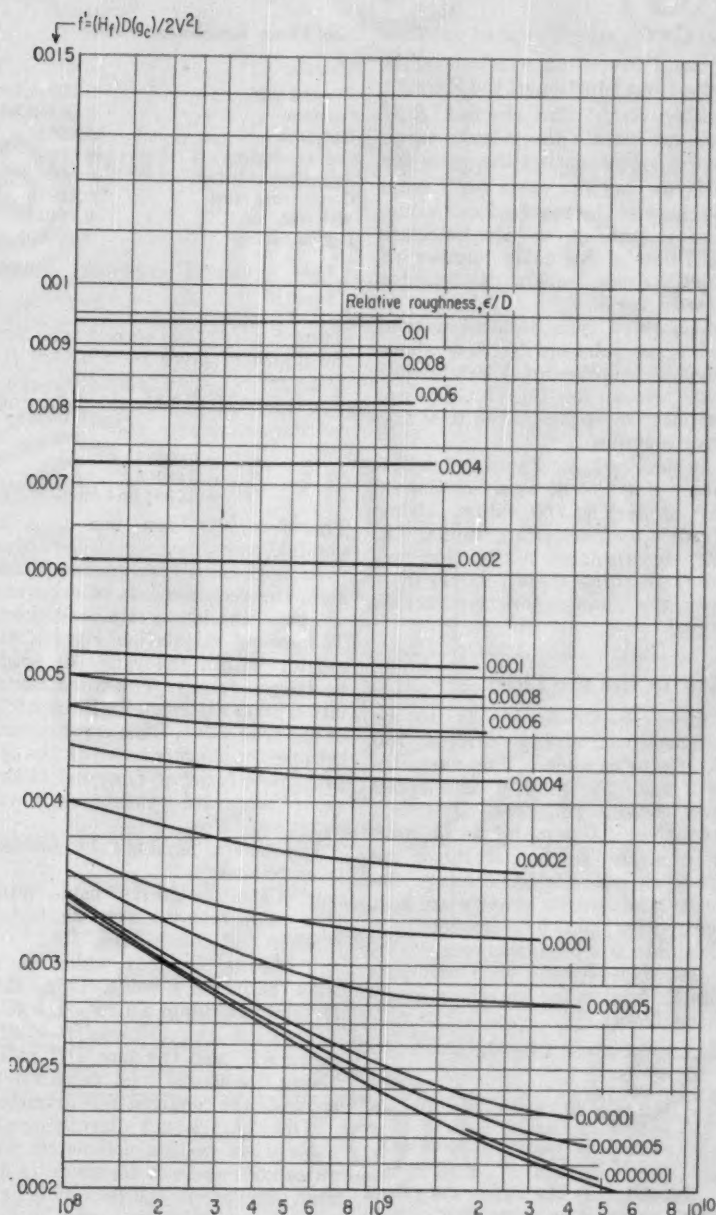
To find pipe diameter when rate of flow and pressure drop are known requires a trial and error solution for Reynolds numbers above 1,200. This new method minimizes the

number of trials and also takes into account a relative roughness factor for various materials of construction.

Before showing how to use this

new chart, let us briefly review the various methods available for calculating flow relations for fluid flow in pipes.

Many studies conducted in the



for Pipe Diameter

field of fluid flow deal with friction factors and Reynolds numbers. A number of charts and nomographs already published relate friction factors and Reynolds number. Gen-

ereaux's chart¹ is one such example. It is often used in plant design problems where extreme accuracy is not required. Another contribution is the

Nomenclature

D	Diameter, ft.
f	Friction factor, dimensionless.
f'	Fanning friction factor where $f' = f/4$.
g_c	Constant = 32.17 lb. mass-ft./lb. force-sec. ²
H_f	Static pressure, ft. of fluid.
L	Length, ft.
R	Reynolds number.
V	Mean flow velocity, fps.
ΔP_f	Pressure drop, lb./sq.ft.
ϵ	Roughness factor, ft.
μ	Viscosity, lb./sec.-ft.
ρ	Fluid density, lb./cu.ft.

article and graphs of Moody² published in 1944. Moody's graphs are based on the Colebrook function. The Colebrook or Colebrook-White equation which covers the entire field of pipe flow above the laminar and critical zones is:

$$1/\sqrt{f} = -2 \log(\epsilon/3.7D + 2.51/R\sqrt{f}) \quad (1)$$

The only disadvantage of the Colebrook equation is that it contains f on both sides of the equation.

Moody in a later article³ published in 1947 offered an approximate solution for f . The basis for this solution is the approximate formula

$$f \approx 0.0055[1 + (20,000 \epsilon/D + 10^6/R)^{1/3}] \quad (2)$$

As formulated by Moody,³ Eq. (2) agrees with Eq. (1) within an error of $\pm 5\%$ in the values of f for Reynolds numbers between 4,000 and 10^7 and for ϵ/D ratios up to 0.01. For most engineering calculations, this error is within the tolerance of the required accuracy.

Types of Flow Problems

Three general problems arise in fluid flow when considering the Fanning equation.⁴ The Fanning equation⁵ is:

$$-\Delta P_f = \frac{2f'V^2L\rho}{g_cD} \quad (3)$$

Sometimes the Fanning equation is written as:

$$H_f = \frac{2fLV^2}{Dg_c} \quad (4)$$

Problem Type	Given	Calculate
1	Pipe size Rate of flow	Pressure drop
2	Pipe size Pressure drop	Rate of flow
3	Rate of flow Pressure drop	Pipe size

We can solve the first type of problem by calculating a Reynolds number and then using a plot⁶ of f vs. R to find the friction factor. Since f' equals $f/4$, we may calculate f' . Then we substitute in Eq. (3) and solve for $-\Delta P_f$.

However, for viscous flow where Reynolds number is less than 1,200, the friction factor f' equals $16/R$. Substituting $16/R$ and $DV\rho/\mu$ for Reynolds number in Eq. (3), we get

$$-\Delta P_f = \frac{32LV\mu}{g_c D^3} \quad (5)$$

Note that Eq. (5) is Poiseuille's equation.⁸ Using Eq. (5), we can solve for pressure drop directly.

We can use a trial and error solu-



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JAMES M. DROTHER is a chemical engineer with Gulf Research and Development Co. He graduated this past June from the University of Pittsburgh with a B.S. degree in chemical engineering. While an undergraduate, Droter worked as laboratory technician in the X-ray diffraction section of the Mellon Institute of Industrial Research. He also worked as junior engineer for Westinghouse Atomic Research. He is a student member of AIChE and a member of Phi Lambda Upsilon, honorary chemistry society and Sigma Tau, honorary engineering society.

tion for the second type of problem or use a graph⁶ on which $1/\sqrt{f}$ is plotted as a function of the Karman number $R\sqrt{f}$. The abscissa $R\sqrt{f}$ does not contain the velocity term. Hence, by calculating the value for $R\sqrt{f}$, we find the value for f from the chart at the required ϵ/D value. Having found f , we now calculate V . Below a Reynolds number of 1,200, we can use Eq. (5) to solve directly for V .

The third type requires a trial and error solution for flow above Reynolds number of 1,200. Below 1,200, we can use Eq. (5). We use the chart to minimize the trial and error solution.

In the chart, the Fanning friction factor f' is plotted as a function of R/f' at various ϵ/D values. Using Moody's approximate formula, Eq. (2), we calculated the friction factor f . Dividing these f values by 4 gives the Fanning friction factors f' .

How to Use the Chart

Problem—Crude oil is to be pumped from storage through 750 ft. of pipe at a mean linear velocity of 8 fps. The pipe is commercial steel whose roughness ϵ equals 0.00015 ft. A pump of 40 ft. head with respect to the density of the crude oil is available. Average viscosity and specific gravity are 1.31 centipoises and 0.85 respectively. Calculate the pipe diameter.

Solution—First, we'll compute the R/f' value for the given conditions from:

$$R/f' = 2V^3L\rho/Hfg_c\mu$$

$$V = 8 \text{ fps.}$$

$$L = 750 \text{ ft.}$$

$$\rho = 0.85 \times 62.4 \text{ lb./cu. ft.}$$

$$H_f = 40 \text{ ft.-lb. force/lb. mass}$$

$$g_c = 32.17 \text{ lb. mass-ft./lb. force-sec.}^2$$

$$\mu = 1.31 \times 6.72 \times 10^{-4} \text{ lb./sec.-ft.}$$

Substituting the numerical values into the equation gives $R/f' = 4.79 \times 10^7$. Using this R/f' value and $\epsilon/D = 0$ for smooth pipe, we find $f' = 0.00375$ from the chart.

We now use Eq. (4) to find the diameter of the pipe for the first trial.

$$D = \frac{0.00375(2)(8)^3(750)}{40(32.17)} = 0.2795 \text{ ft.}$$

Then, we find a new ϵ/D ratio = $0.00015/0.2795 = 0.000537$.

From the chart at the same R/f' value of 4.79×10^7 , we find the value of f' is 0.00477 for the new ϵ/D parameter equal to 0.000537.

Use These Roughness Values

Material	ϵ , Ft.
Riveted steel	0.003-0.03
Concrete	0.001-0.01
Cast iron	0.00085
Galvanized iron	0.0005
Asphalted cast iron	0.0004
Commercial steel	0.00015
Wrought iron	0.00015
Drawn tubing	0.000005

Using Eq. (4), the second trial for the diameter gives $D = 0.3420$ ft. or 4.1 in.

A third trial yields the following results:

$$\begin{aligned} \epsilon/D &= 0.00438 \\ f' &= 0.00465 \\ D &= 0.0334 \text{ or } 4 \text{ in.} \end{aligned}$$

Therefore, we can use a 4-in. nominal size pipe.

In most cases encountered in design, the requirements of accuracy are governed by certain conditions. The second calculation gives a diameter within the range of engineering accuracy. The third calculation gives a diameter within $\pm 5\%$ of the true value. This error occurs because the chart is based on the approximate form⁶ of f instead of the more accurate Colebrook-White equation.

For general purposes the solution is as follows:

- Calculate the R/f' value. With this value find the friction factor f' when ϵ/D equals zero.

- Using Eq. (4), calculate D with the initial f' value. Using this D value, calculate a new ϵ/D ratio.

- Find new value of f' at the same R/f' and the new ϵ/D ratio. Using the second trial value for f' , compute the required pipe diameter.

The chart is not directly applicable when certain volumetric flow rates are required. However, in design calculations the velocity is usually chosen between 5 and 10 fps. We can calculate the volumetric rate from the pipe diameter obtained by using the chart and the design velocity.

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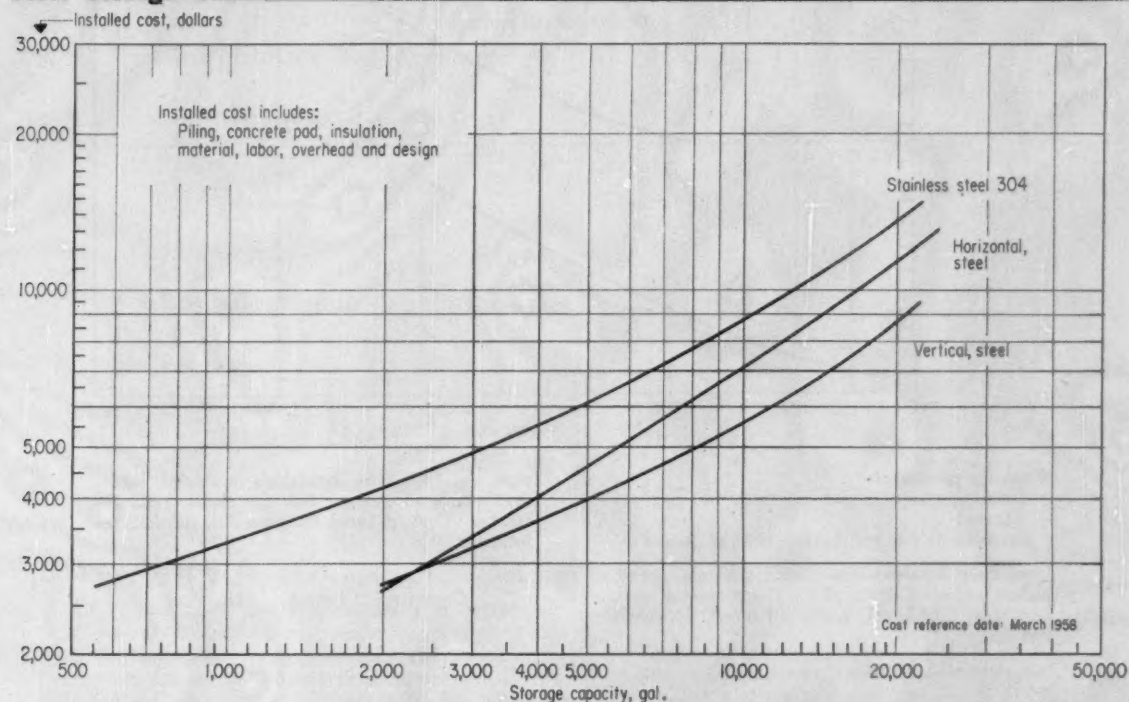
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CE Cost File—IV

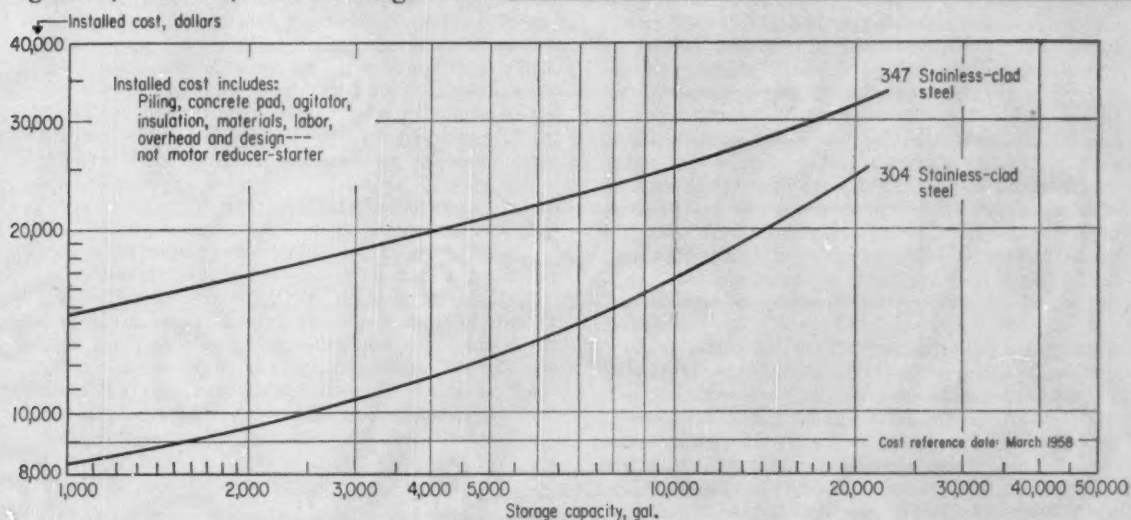
Harold Cushin,
General Aniline & Film Corp., Linden, N. J.

Current Costs of Vessels and Motor Reducers

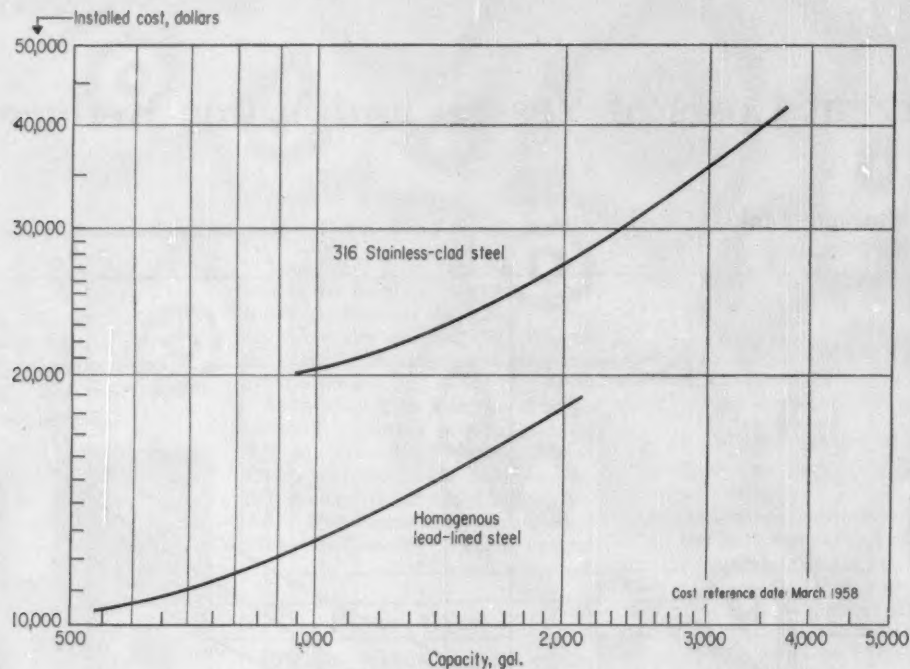
Steel Storage Tanks



Agitated, Vertical, Steel Storage Tanks



Jacketed Kettles



Working pressures

Stainless-clad: 50 psi. internal, 100 psi. external

Lead-lined: 100 psi. kettle, 100 psi. jacket

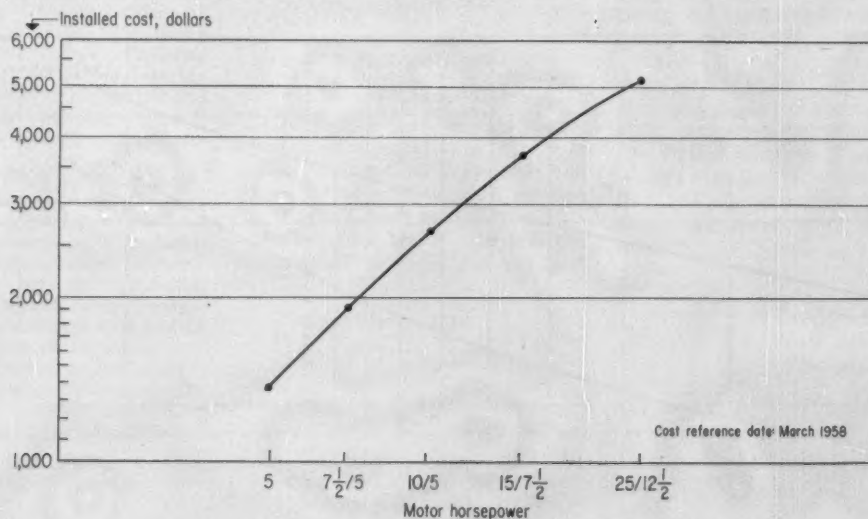
Lead-lined kettles: cost includes kettle, cover, jacket, agitator, drive, shaft, thermometer well, blowpipe, insulation, material, labor, overhead and design.

Stainless-clad kettles: cost includes kettle, cover, jacket, agitator, thermometer well, blow-

pipe, safety valves, insulation, material, labor, overhead and design, but no motor reducer-starter. Cost of these includes 316 SS coils as follows:

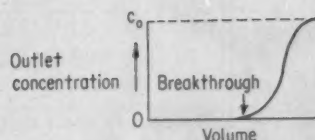
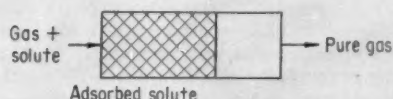
Capacity, Gal.	Length, Ft.	Diameter, In.
1,000	300	2
1,500	330	2
3,000	540	2½
3,500	552	2½

Motor Reducer-Starter Combination for Agitators

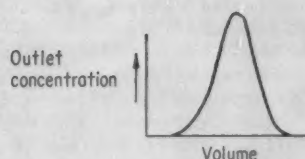
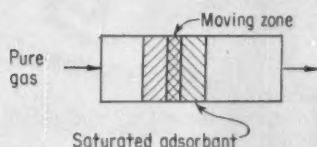


Mass Transfer Behavior in Fixed Beds

• Adsorption or Ion Exchange



• Chromatographic Separation



JAMES O. OSBURN, State University of Iowa, Iowa City, Ia.*

UP TO this point in the mass transfer series, we have been dealing with mass transfer between moving phases. A different treatment becomes necessary when one of the phases is stationary. Adsorption, ion exchange and gas chromatography are important applications of this fixed bed operation. In this article, we show how to use special design methods that have been developed for these operations.

The three operations mentioned are alike in one respect. In the usual method of operation there is a stationary bed of solid and a moving fluid phase flowing through the bed. The solid removes solute from the flowing stream or gives up solute to the stream. The concentrations at any given point change with time, so we have an unsteady state operation.

Here, we are primarily interested in showing how the outlet concentration changes with time and how this is affected by the length of the packed bed.

Industrial separations are sometimes made by adsorption in a moving bed, such as in the Hysorption process. Design for this case is similar to that for gas absorption, with the solid adsorbent taking the place of the liquid solvent. We can use mass transfer coefficients, transfer units or theoretical plates for the calculations. We have described these calculations in previous articles [*Chem. Eng.*, June 16, 1958, p. 183; July 14, 1948, p. 147], so shall not repeat them here.

* To meet your author see *Chem. Eng.*, Mar. 24, 1953, p. 169.

Two Types of Fixed Bed Operation

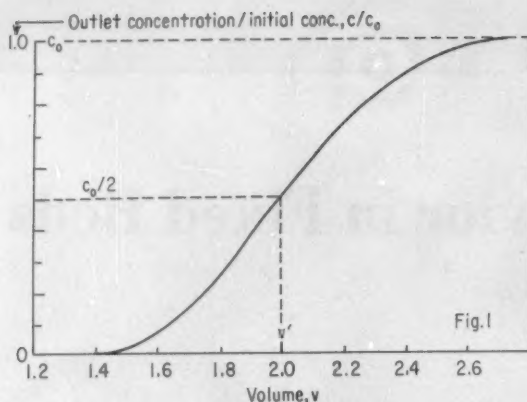
Fixed bed units are operated according to two basic procedures. One is simple adsorption, the other elution or chromatographic separation.

We use simple adsorption to remove a substance from the fluid stream. Starting with a fresh bed, we pass a solution or gas mixture into the column as shown above. The bed may be a simple solid adsorbent, a liquid held on an inert solid, or some types of exchange resin. Strongly basic resins have a different mechanism, therefore behave differently.

At first the fluid contacts successive portions of fresh adsorbent and the solute content is reduced practically to zero. After a certain amount of fluid has passed through the column the bed becomes saturated, and we get a condition known as breakthrough. The concentration of the effluent then rises fairly rapidly to the original concentration, as little further adsorption takes place. A typical fixed bed adsorption curve is also shown in the above diagram.

We use elution or chromatographic separations to separate substances adsorbed on a bed of adsorbent. As shown above, we place the solute in the column and then send in a pure solvent to wash the solute along. If we use a liquid, this is called an eluent, with gases it is a sweep gas.

Components in the solute are washed through the column as bands or zones at slightly different rates,



because of differences in their distribution between solid and fluid phases. The solution on the upstream side of a zone is unsaturated and dissolves the solute. In the case of gas chromatography, the mechanism is evaporation instead of dissolution. On the leading or downstream edge, the solution is supersaturated with respect to the fresh adsorbent and so some solute is redeposited.

The concentration history of the fluid leaving the chromatographic column is similar to that shown in the diagram on p. 143. This composition is shown for a single component. Other components would give similar curves, displaced more or less completely. Displacement of the curves for different substances makes possible a separation or analysis.

Use Theoretical Plate Methods

In this article, we shall describe how theoretical plate methods apply to fixed bed operations. As with packed column distillation, absorption or extraction, we assume that the column is made up of theoretical units or plates. The solute concentrations in the solid and in the fluid phases are assumed to be constant within each plate and are in equilibrium.

Fixed bed operation differs from packed column distillation in that the solid phase is stationary and the solute adsorbed on it doesn't move as long as it remains adsorbed. Another difference is fixed bed operations are unsteady state operations. Hence, we must use differential equations to describe them.

These equations have been written and solved for a number of cases by Glueckauf [*Trans. Faraday Soc.*, 51, 34-44 (1955)]. Let's examine some of the equations he obtains and see how we can use them.

For Adsorption: Look at Breakthrough

Let's consider an adsorber first. We start with fresh adsorbent and feed a solution whose concentration is c_0 . The total volume of solution up to time t is called v . By plotting the composition of the fluid which leaves the adsorber against the volume of solution v , we get a curve such as Fig. 1. We will let the volume v' be that at which $c = c_0/2$.

The following expression then relates the composition of the effluent solution to the volume and the number of theoretical plates.

$$\frac{c}{c_0} = \frac{1}{2} - \frac{\phi}{2} \left[\sqrt{N} \left(\frac{v' - v}{\sqrt{v'v}} \right) \right] \quad (1)$$

The term ϕ of Eq. (1) is the normal curve of error which is defined by the equation:

$$\phi(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^x e^{-(x)^2/2} dx \quad (2)$$

Values of this function which is an important one in statistics are tabulated in the "Handbook of Chemistry and Physics."

To illustrate, let's assume that Fig. 1 represents the results of an experiment and that it's drawn to scale. We scale off some values as follows:

c/c_0	v
0.1	1.67
0.3	1.86
0.5	2.00
0.7	2.15

For each point, calculate $(0.5 - c/c_0)$. This equals the error function. From a table of this function, we find the value of $\sqrt{N}(v' - v)/\sqrt{v'v}$. At $c/c_0 = 0.5$, we find the volume v' equal to 2.0. Now, we can calculate N for each point.

c/c_0	$0.5 - c/c_0$	$\frac{\sqrt{N}(v' - v)}{\sqrt{v'v}}$	N
0.1	0.4	1.280	50
0.3	0.2	0.525	52
0.5	0	0	*
0.7	-0.2	0.525	52

* Indeterminate

The calculations show that the column has about 52 theoretical plates.

If the breakthrough curve has the correct shape, we need only one point on the curve to calculate the number of theoretical plates. Glueckauf suggests that a convenient point is that at which $\sqrt{N}(v' - v)/(\sqrt{v'v}) = 1$.

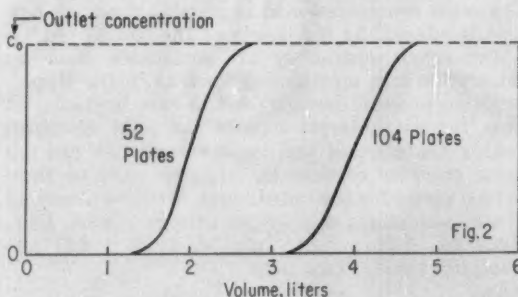
Referring to a table of the error function, we find its value equals 0.3413 when $\sqrt{N}(v' - v)/\sqrt{v'v} = 1$. Then, $c/c_0 = 0.5 - \phi/2$ (1) = 0.1587. Also, the number of theoretical plates is

$$N = \frac{v'v}{(v' - v)^2} \quad (3)$$

From Fig. 1, we find $v = 1.74$ when $c/c_0 = 0.1587$. Hence, $N = (2)(1.74)/(0.26)^2 = 52$ plates.

Effect of Increasing Number of Plates

We can show from Eq. (3) how increasing the number of theoretical plates increases the sharpness



of the breakthrough. A reasonable assumption is that the height of a theoretical plate is the same throughout the column. Therefore, if we double the column height, we double the number of theoretical plates. Let's calculate the breakthrough curve for this situation.

The amount of solute adsorbed depends mainly on the amount of adsorbent. This will be doubled. Therefore, we can assume that v' is twice its previous value or 4. For $N = 104$, we use Eqs. (1) and (2) to get the curve of v vs. c/c_0 . The resulting curve is shown in Fig. 2.

Elution Curve Gives Number of Plates

We can calculate the number of theoretical plates in an elution or chromatographic column by using the equations derived for this method of operation.

We start with a narrow band of solute at the top of the column. The rest of the column contains solute-free adsorbent. We pass an eluting solution or sweep gas at constant rate through the column which moves the band toward the outlet.

Glueckauf derives this equation for the outlet concentration in the eluent liquid or sweep gas:

$$c = c_{max} e^{-K} \text{ where } K = \frac{N}{2} \left[\frac{(v_m - v)^2}{v_m v} \right] \quad (4)$$

In this equation,

- v = Total volume of sweep gas
- v_m = Volume at which the peak of the concentration curve is reached.
- N = Number of theoretical plates from the center of the original band to the bottom of the column. Under usual conditions, the number of plates in the band is negligible.

Another equation relates the maximum concentration to the number of plates.

$$c_{max} = \frac{m}{v_m} \sqrt{\frac{N}{2}} \quad (5)$$

where m is the area under the elution curve, or

$$m = \int_0^{\infty} c dv \quad (6)$$

These equations permit calculation of the number of theoretical plates. Let's illustrate two convenient methods with the aid of an example.

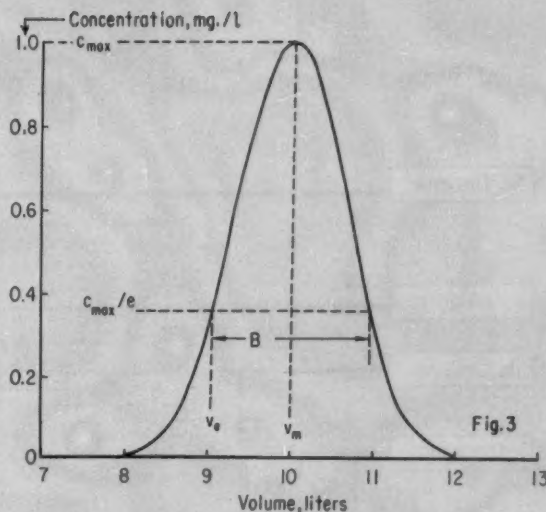
Find Plates for a Chromatographic Column

In this example, let's suppose that the elution curve obtained in an experiment is that plotted in Fig. 3. We might find N by fitting the data to Eq. (4), but two other methods are more convenient to use.

In one of these methods we make use of Eqs. (5) and (6). First, we find m by graphical integration of the area under the curve in Fig. 3. We do this by methods explained in *Chem. Eng.*, Nov. 1957, p. 278. The area is 1.68 mg. when c is in mg./l. and v in liters.

Next, we rearrange Eq. (5) to solve for N .

$$N = 2\pi \left[\frac{c_{max} v_m}{m} \right]^2$$



As shown in Fig. 3, $c_{max} = 1$ mg./l. and $v_m = 10$, so $N = 222$ theoretical plates.

For the other method, we define a new term v_e the elution volume, which is the volume when $c = c_{max}/e$ or $c_{max}/2.718$. As shown in Fig. 3, there are two values of volume for each value of c .

We define the bandwidth B as the difference between these two volumes for the value $c = c_{max}/e$. Then from Eq. (4), $c_{max}/e = c_{max} e^{-K}$ where $L = N/2 [(v_m - v_e)^2 / v_m v_e]$. From the preceding expression, the relationship $N = 8(v_m/B)^2$ is derived.

For the example, at $c = c_{max}/2.718$ or 0.368, we find v_e equals 9.05 and bandwidth equals to 1.9. Thus:

$$N = (8)(10)^2 / (1.9)^2 = 22 \text{ theoretical plates}$$

Equations Depend On Assumptions

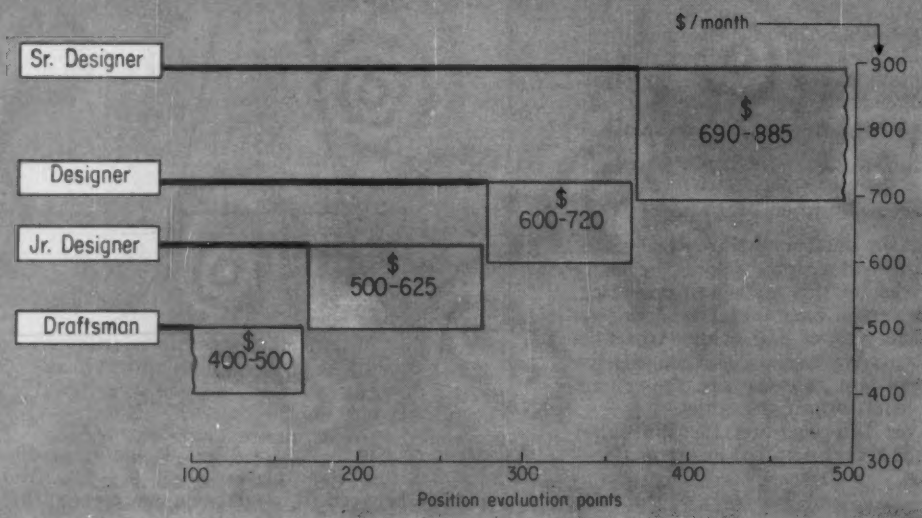
The preceding treatment of mass transfer in fixed beds depends on a number of assumptions. These correspond well to situations usually encountered, but in some cases may lead to departure of actual results from predicted values.

One assumption is that the number of theoretical plates is very large. This is usually the situation in adsorption columns. For example, an 11-ft. gas chromatographic column has been reported by James and Martin, [*Biochem. J.*, 50, 679 (1952)] to contain 2,000 theoretical plates.

Also, the theoretical plate treatment applies only when we have equilibrium between the solute and solution. This condition is most closely approached when the flow rates are low. Ion exchange, on the other hand, often requires a different treatment.

If we don't approach equilibrium at each point in the column, we must use mass transfer coefficients or transfer units. Although we do not plan to take up this subject in the CE Refresher, detailed coverage of the subject is given in articles by Hougen and Marshall, [*Chem. Eng. Progress*, 43, 197 (1947)] by Hiester and Vermeulen, [*Chem. Eng. Progress*, 48, 505 (1952)] and by Rosen, [*Ind. Eng. Chem.*, 46, 1590 (1954)].

Point System Measures Jobs, Sets Salaries



Putting a Value on Engineering Work

Even in a small department, this system will help you evaluate engineering effort. This issue: The Job. Next issue: The Man.

Robert G. Trout, Peerless Pump Div., Food Machinery & Chemical Corp., Los Angeles, Calif.*

The objective of job evaluation is to provide a basis for a just wage and salary system, administered with maximum objectivity and in a manner such that any differentials are correct and explainable by reason.

You can achieve this objective by doing these two things:

- Classify the various jobs and establish a written definition of the job to be performed.

- Evaluate and measure the performance of the individual against the defined job.

Often the expense of setting up and maintaining such a system restricts its use to large organizations. We have been using job evaluation successfully in a 70-employee engineering department. In this article we'll explain how we evaluate our engineering positions. Next issue we'll discuss the evaluation of individual performance.

*Your author's biography will appear with Part II in our next issue.

Most common methods of classification and measurement are:

1. Unilateral action by the boss.
2. Individual bargaining.
3. Collective bargaining.
4. Systematic salary administration using a scientific evaluation scheme.
5. Combination of two or more of the above methods.

How to Classify a Job

To classify a job, we must consider and define the function to be performed, assign an objective value to the job and then relate this value to the whole engineering department.

In our system, we consider these eight factors:

1. Major functions of the job and its purpose.
2. Regular duties performed. List the duties in order. What do you do about the duties? What percent of your time is spent on each?
3. Special or occasional duties.

Regular duties done occasionally and duties done at special request of supervisor.

4. Responsibility for personnel.
 - a. Line responsibility. Number of employees reporting direct. Number of employees reporting through positions reporting to you.
 - b. Functional responsibility for personnel.

5. Responsibility for business development. Contacts that influence decisions about new products. Contacts that influence customers. Influence on profit margins. Responsibility for decisions about sales and market possibilities. External relations with customers, vendors, unions and technical societies.

6. Responsibility for physical resources. Raw materials and supplies. Capital additions and replacements. Maintenance and repair. Protection of resources. Cost reduction and expense control. Record keeping.

7. Planning and decision making.

EDITED BY R. F. FREMED **YOU & YOUR JOB**

Types of decisions made: prices, shipment, instruments, policies and procedures, production priority and schedules, product design and development. Who shares these decisions? Who reviews them, and how soon?

8. Knowledge, skills, experience and special background. Specialized knowledge: education, apprenticeship, experience, minimum time in job. Human-relations skills. Administrative skills. General knowledge required.

Key Jobs Help Rank Others

An evaluating committee—usually consisting of members of top and upper-middle management—by considering survey replies incorporating the factors given above, is then equipped to classify the jobs.

Only key jobs need be evaluated, since other jobs can be hinged relative to the key jobs and the detailed evaluation of these other jobs can be left to committees of department heads or line supervisors.

In very small companies where there is personal contact between the "Chief" and the people concerned, and if the Chief can achieve a high degree of objectivity, his unilateral evaluations and rankings may be satisfactory. Larger corporations need a more objective method because of the lack of personal contact between decision making groups and the work of individual engineers; and to head off the tendency of various departments to protect (more than is necessary) their particular spheres of influence.

Several Methods for Grading

Ranking or grading methods consist of examination of the job surveys and—starting with the lowest—classifying each job relative to another by comparing the relative value to the company of the material presented in the job surveys. Note that the job survey becomes a necessary part of the method. Many industries use such a system.

The factor-comparison method was originated by Eugene Bengé about 1928. Bengé's plan consists of taking five factors and analyzing all jobs on the basis of one of these factors, then examining the second

factor for all jobs, etc. The factors are given ¢/hr. values and at the conclusion of the comparison, total ¢/hr. value for each job is added up. This will correctly place each job relative to other jobs.

Bengé never intended that his method be used in an engineering group. However, with proper selection of the factors, his method can be made to work satisfactorily.

Point systems have been effective in evaluating engineering positions. Most common plans are the straight-point plans and the degree or weighted-point plans. The straight-point plans assign level of points to each of the eight factors, for example, that we have listed above. A draftsman might receive a second-level rating in knowledge, skills and background required for his job; whereas the assistant chief engineer might receive a fifth-level rating in this category. The sum of the point values relates the various jobs to one another.

Our Own Preference

We prefer to use a system that combines the point value associated with a position and a degree of excellence within a position. In this way each major job in a department may have three or four degrees of skill associated with the position. Multiplication of the degree values and the point values to a total results in a weighting of the broad categories and finer lines of distinction.

For example, the job of designer has point and degree values associated with broad categories of responsibility as follows:

Cate- gory	Degree	Point Value	Total
A	3	2	6
B	8	5	40
C	5	3	15
D	8	5	40
E	7	8	56
F	12	10	120

Total Points 277

- A. Responsibility for personnel.
- B. Responsibility for business development.

C. Responsibility for physical resources.

D. Planning.

E. Decision making.

F. Knowledge required.

Now the junior designer has lower requirements in some categories (and the same in other categories) than the designer. Similarly, the senior designer might have higher requirements in some categories than the designer. So rather than adjust the basic point values, we adjust the degree values.

Doing this we arrive at a total point value of 170 for a Jr. Designer; 277 for a Designer; and 368 for a Sr. Designer. In this way both the junior and senior designer jobs hinge around and represent levels of a basic designer's job. We have indicated the actual salaries associated with these point totals in the chart on the facing page.

Point values have thus enabled us to give each job a relative importance and the job survey material is then reviewed and rewritten to correctly define each job relative to every other job.

Advantages Are Numerous

Advantages of this system are numerous:

- Management need only be concerned with key positions.

- Key positions can be so described that they compare favorably with similar positions in other industries.

- Shading of jobs in a department is simple and automatic.

- If proper interdepartmental point values are assigned, then shading and comparison of jobs between departments is automatic.

- Wage and salary scales can be adjusted by comparison with key positions in other companies.

We have been using this system effectively in a small engineering department (70 people total). But job description and evaluation is only the first—and very important—step in just wage and salary administration. In Part II of this article we'll explain how we measure individual performance.

For a complete description of the responsibilities and duties of a typical engineering job, please turn page.

Sample Job Description—Sr. Designer**Section I—Position Duties**

Purpose of Position—Under general direction, assumes the responsibility of supervising and planning engineering design work, usually in the form of a project, from inception to completion.

Regular Duties

1. Supervises and plans engineering design work involving the design and development of additions to the product line and the redesign or modification of existing products.
2. Reviews, accumulates and tabulates all necessary information and engineering data required for determining the basic development and design of new, redesign of existing products.
3. Experiments on existing products with a view to creating greater functional efficiency.
4. Creates original drawings for products in the development stage.
5. Prepares project specifications and applications, estimating complete cost and time required to complete the project.
6. Decides (subject to review) the type of design and the number of sizes most suitable based on theory and experience.
7. Prepares and/or supervises layouts for determining final design requirements.
8. Supervises the issuing of shop orders for machining, assembling and completing pilot model.
9. Consults and cooperates with Production, Manufacturing, Foundry and Pattern Shop regarding procedures and design modification which may be essential for economic production of individual parts or completed product.
10. Supervises drawings and/or tabulations of all data pertaining to the product that is required by Sales, Advertising, Pricing and Manufacturing Departments.

Special or Occasional Duties

1. Advise Sales Dept. and customers relative to special features, general construction and possible limitations of product for various installations.
2. Write technical articles for publication.
3. Write special technical bulletins for Sales and Advertising.
4. Collaborate with colleges on combined experiments and reports on pumping problems.
5. Prepare anticipated performance and size data for proposal section to use in quoting on jobs which require pumps not in the standard line.

Section II—Analysis of Basic Responsibilities

Responsibility for Personnel—Incumbents in the positions of Designer, Jr. Designer, Design Draftsman and Draftsman report directly to the Sr. Designer. Advise, instruct and train (with functional responsibility) Specifications Engineers, Proposal Engineers and Design Draftsmen. Advise and instruct (with functional responsibility) Purchasing, Production, Stores, Manufacturing, Advertising, Pricing, Test Lab and Sales Engineers.

Responsibility for Business Development—Responsible for the development of new products or the improvement of existing ones, which will open new areas for sales. Studies details of competitive equipment to see if new products are warranted. Consults with Sales about fitting proposed designs into good competitive positions.

Responsible for completion of assigned projects which may include the development of new products, the redesign or adaptation of existing design, considering appearance, cost of material, manufacturing cost, application of product and mechanical and functional efficiency.

External relations involve technical and specialized contacts with potential vendors, consumers and users of the product in securing materials, estimates, testing and proving the product. Cooperates with universities on pump and sump research. Writes articles and technical bulletins for publication.

Responsibility for Physical Resources—Recommends expenditures and sometimes on his own approval of up to \$10,000 for maintenance and repairs and pattern repairs; up to \$40,000 for development projects including research, design pilot model, patterns and tooling.

Has custody of up to \$5,000 worth of raw materials and supplies, semifinished and finished products; between \$5,000-\$10,000 worth of equipment and supplies.

Applies cost considerations which are inherent in the design of product with responsibility for cost reduction and expense control. Considers such things as selection of material, simplification of manufacturing, adapting product to present methods and tooling, increasing quality and performance of existing parts and products without increasing costs.

Supervises the preparation, maintains, approves or reviews the following records: master lists, general engineering data, sales engineering data, test data, engineering curves, pattern records and field trouble reports.

Section III—Planning and Decision Making**Planning**

1. Plan and prepare project applications.
2. Prepare section work schedule to meet time limits.
3. Plan for pattern requirements and construction.
4. Plan for construction of pilot model and tests.
5. Plan so that data and drawings are made available on schedule to Advertising, Pricing and Shop Departments.
6. Plan so that necessary engineering data, specification sheets, test data for order processing and proposal section are available on schedule.

Decision Making

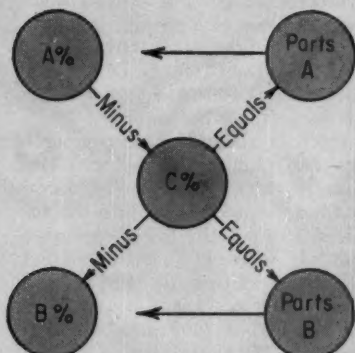
1. Decides scheduling procedures for work of section.
2. Decides drawing, data and record requirements for the project.
3. Decides basic design changes and/or alterations.
4. Decides amount of and construction of pattern equipment required by the project. (Subject to review by Supervisor.)
5. Decides (subject to review) the magnitude of a project by determining the market requirements, such as selecting the number and sizes of products to make up a project.

Section IV—Knowledge, Skills, Experience

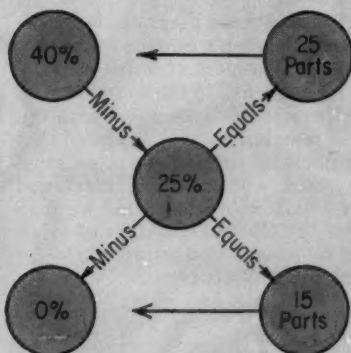
Knowledge and Experience—4 yrs. of college or equivalent, with emphasis on hydraulics as they relate to pump design. Minimum 5 yrs. experience in design and application of pumping equipment. Knowledge of equipment in shop and standard shop practices. Knowledge of outside shop practice and requirements, such as foundry, pattern shop, etc.

Ability—Ability to cooperate with others and understand their problems. Ability to plan, control and manage complete projects. Ability to work under pressure and meet deadlines. Ability to train and supervise employees.

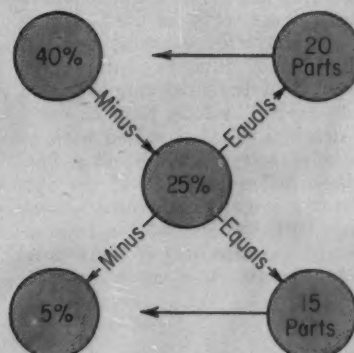
Internal Relations—It is necessary to contact domestic and export Sales, Advertising, Pricing, Cost, Production and all Manufacturing Departments of the plant either to submit or receive information pertaining to the efficient fulfillment of the functions and requirements of the Section.



A, B, C = concentrations of initial, diluting and final solutions.



Case 1—Diluent contains only pure solvent, i.e., B = 0%.



Case 2—Diluent contains some solute, i.e., B = 5%.

Old Trick Averts Error in Figuring Dilution

Non-technical personnel can easily figure dilutions with assurance and dispatch if you give them Pearson's Square.

William H. Fischer

General Engineering Laboratory, General Electric Co., Schenectady, N. Y.

In a recent issue of *Chemical Engineering* (p. 168, Apr. 21, 1958) my co-worker, Merton Allen, presented a simple method of calculating dilutions with a single setting of the slide rule. The method was limited to cases where the diluent is pure solvent. There is a very old method, sometimes called Pearson's Square, which has been described in various handbooks and periodicals (most recently, in this magazine, 25 years ago). It has various advantages such as the fact that it is not limited to dilution with pure solvent. Also, it readily lends itself to use by operating personnel with little or no mathematical training. It is therefore worth describing again for those who do not know it.

The diagrams above tell the story. The quantities involved are set down on the corners of a square and then two subtractions are made as indicated by the arrows. The lefthand diagram shows that if a solution or suspension contains A% of a solute and it is desired to dilute

this with another solution containing B%, to obtain a product containing C% solute, then $A - C$ = the number of parts of B to be used, and $C - B$ = the number of parts of A to be used.

Up to this point subtraction is the only mathematical operation required. Of course, if it is desired to use a definite quantity of A, or to produce a definite quantity of C, then a calculation of simple proportion must be added to convert the "parts" of A and B to the desired quantities.

This method lends itself readily to use in the plant because the circles, labels and instructions can

COMING OCTOBER 6: Tank Control Siphon Can't Lose Prime

By C. F. A. Roberts, Winner of the July Contest

★ How Readers Can Win

\$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award \$50 each four weeks to the author of the best short article received during that period and accepted for Plant or Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

\$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional \$100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates (\$10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, *Chemical Engineering*, 330 W. 42nd St., New York 36, N. Y.

easily be painted on a blackboard for routine use. It should be noted that the method is identical whether the concentrations are expressed as volume or as weight percentages.

Diagrammed in the center on the preceding page is an example where pure solvent is to be used. If the original solution contains 40% of solute, the diluent contains no solute, and the final concentration is to be 25% solute, then 25 parts of original solution, mixed with 15 parts of solvent, will yield a final concentration of 25%. If the percentages are expressed on a volume basis then the method can be completely accurate only if there is no volume contraction on adding the

solute to the solvent. If the result is to be expressed in terms of weight rather than "parts," then to make 100 lb. of final solution we need $(25/40)100 = 62\frac{1}{2}$ lb. of original solution, plus $(15/40)100 = 37\frac{1}{2}$ lb. of solvent.

The righthand diagram shows the use of Pearson's Square for a case where the diluent contains some of the solute—5% in the example. Use of the method is identical with the first case but the result shows that 20 parts of original solution must be added to 15 parts of diluent, and for 100 lb. of final solution we shall need $(20/35)100 = 57.2$ lb. of original solution, added to $(20/35)100 = 42.8$ lb. of diluent.

Save With Direct-Fired Gas

Lloyd M. Polentz

Professional Engineer, Whittier, Calif.

Chemical engineers need heated air for many purposes—for drying, removing solvents, setting paint, and polymerizing chemical compounds, to name a few. Most commonly the air is heated indirectly, but in many cases the most economical solution is to use direct-fired gas heaters in which the flame burns directly in the flow of air to be heated.

Most such hot air is provided by using steam in finned heat exchangers through which the air is blown. The heat exchangers are large and expensive, the steam lines may be long, and the pressure drop through the exchangers means a larger blower than otherwise would be needed. Even when filtered air is used, there is considerable maintenance on the exchangers.

If direct gas firing can be used, many of these problems and much of the capital investment can be eliminated. Very little equipment is needed and heat transfer is almost 100% since all the flue gas mixes with the heated air.

There are, of course, some possible objections to this type of heater, in addition to the fact that it is unconventional. There is the chance of an explosion if the flame should be extinguished. In some processes the material being heated may be damaged by the products of combustion. This last objection

would, of course, rule it out. However, there are few materials that will be harmed by the carbon dioxide and the small amount of water vapor that will result from the combustion of the gas. In some processes, also, an open flame can not be tolerated in the processing area.

The problem of an open flame may have a solution in some cases—and not in others. The heater flame can be almost completely enclosed and it is usually possible to find a location where an enclosed, guarded flame will not be particularly objectionable.

Explosion protection can be approached two ways. First, there should be fail-safe burner controls which require both air flow and heat to maintain the flow of gas to the burner. Then, should the thermostat control fail, there should be a large enough flow of air through the heater so that the gas concentration in the air will be less than 10% of the lower explosive limit. This figure is that required by most insurance companies. When the fuel is natural gas this requirement is easily met, as we shall see.

Assume a natural gas composed of 85% methane and 15% ethane, which will have a lower heating value of about 1,000 Btu./cu. ft. with volume measured at 60F. and 30 in. Hg. The lower limit of flammability is 4.6% by volume. Hence,

the volumetric ratio of air to gas must exceed $(1/0.046) \times (1/0.1) = 217$ to exceed the requirement of gas concentration being less than 10% of the lower explosive limit.

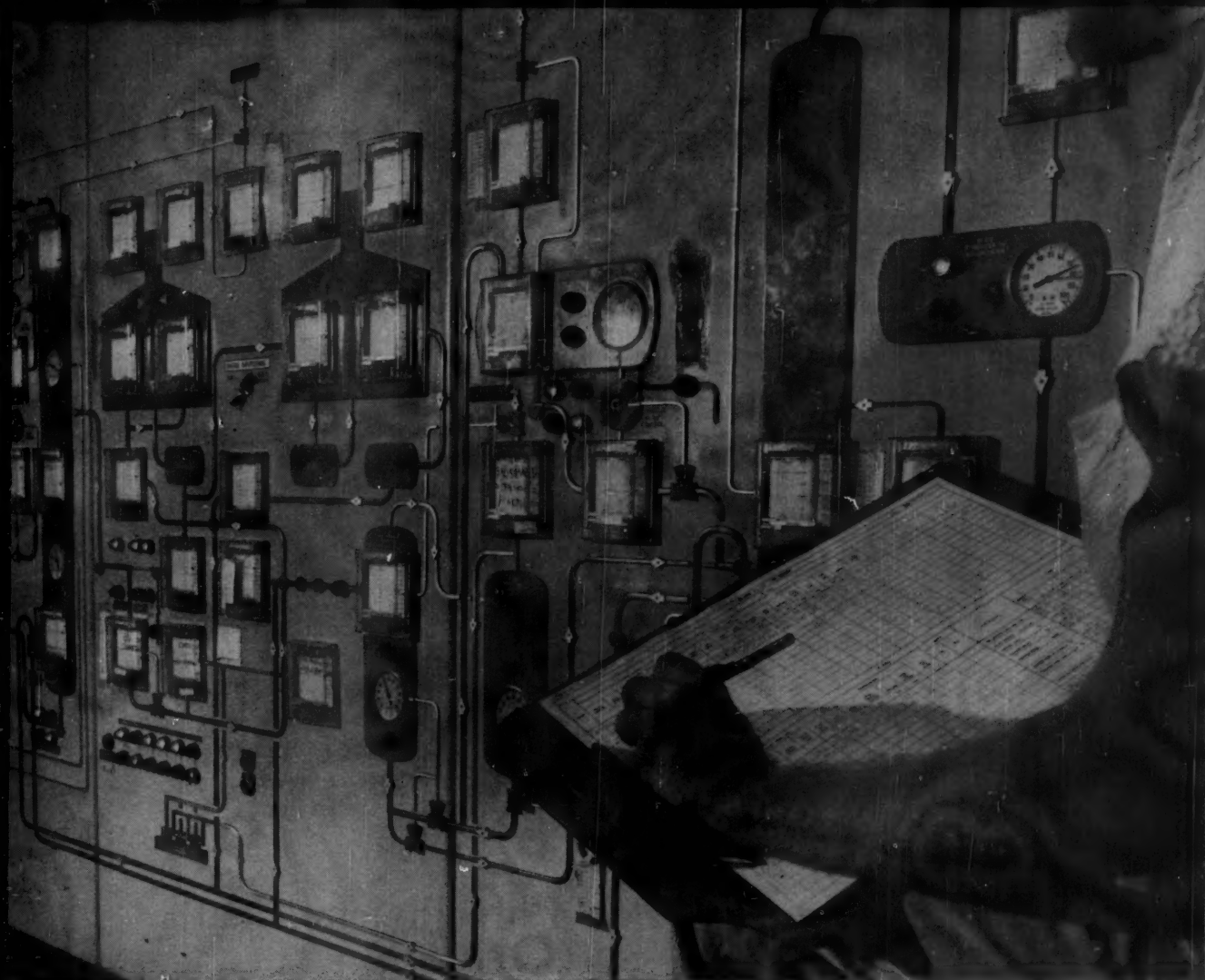
Now, let's see what heating can be accomplished. The specific heat of air at constant pressure is 0.241. Since air weighs about 0.076 lb./cu. ft. at 60F., then 1 cu. ft. of gas can heat $1,000 \div (0.076 \times 241 \times 140) = 390$ cu. ft. of air from 60 to 200F.—which is about the air temperature that would be reached with low pressure steam. This is 80% more air than needed to maintain the required 10% of the lower explosive limit. If we used just the needed ratio the resulting air temperature would be $60 + [1,000 \div (0.076 \times 241 \times 217)] = 240$ F. final air temperature. If the problem is solvent removal, then the excess air can be used to remove solvent from the material.

If there is a considerable amount of solvent to be removed from the material to be heated, then the amount of air to handle this solvent would probably be insufficient if the 10% of lower-explosive-limit requirement were adhered to. In this case a safe installation could be achieved (and probably at a total cost lower than would be required for a conventional steam-heat-exchanger type of installation, even if a steam supply should be available) by installing a continually operating monitoring device to check the gas concentration at different points throughout the system.

With such a device considerable deviation from the 10% of lower-explosive-limit requirement can ordinarily be obtained.

Direct-fired gas heaters are not, of course, the answer to all heating problems. There are, however, many cases where such a heater can save a considerable proportion of the initial investment, give lower heating cost and also solve the "insufficient space" problem which is often a headache of the plant engineer. Since it takes only a few calculations to show whether or not such a unit would be desirable, the potential saving certainly warrants tentative consideration of this type of heating.

One final word of caution, however. Be sure to clear with your insurance underwriters before making any final plans, and have a complete analysis at hand when you discuss the problem with them.



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And Kemp dryers, operating on the dynamic drying principle, are noted for dependable operation. Rugged Kemp dryers will do your drying job around the clock,

month after month, without stoppages or major maintenance. Kemp design reduces utility and operating costs, uses desiccants more efficiently, and eliminates process gas contamination. Units dry to lower dew-points to give your processes and instruments highest possible protection.



Call your Kemp Representative, listed in the Chemical Engineering Catalog, for detailed information and a no-obligation survey of your dryer needs. Or write direct, for Bulletin D-100. The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.



Kemp Convection Dryers



Kemp Inert Gas Generators



Kemp Industrial Carburetors



Kemp Oriol Dryers

	Low-Density Polyethylene (Typical Values)	High-Density Polyethylene (Typical Values)
Density, gr./cc.	0.92	0.95-0.96
Acid resistance	Excellent, except against strong oxidizers.	Excellent, except against strong oxidizers.
Alkali resistance	Excellent	Excellent
Resistance to oils and greases	May swell	Some swelling.
Resistance to solvents	Excellent, except against some chlorinated and aromatic solvents.	Excellent, except against some chlorinated and aromatic solvents.
Anti-stick properties	Fair	Good
Tensile strength, psi.	1,800	3,000-5,000
Max. use temp., F.	180	250
Min. use temp., F.	-60	-130
Hardness (Shore D)	45	60-70
Flammability	Slow burning.	Slow burning.

Coating of process equipment with low-cost, high-density polyethylene becomes practical with a new technique.

Equipment Can Now Don Polyethylene Coat

You can now have your chemical equipment coated with low-cost polyethylene. A recently developed technique produces a lining which is standing up very well to a variety of chemical corrodents in plant applications.

► **Unique Method**—Tank Lining Corp., Pittsburgh, Pa., has come up with a unique flame-spray method for high-pressure, high-density linear polyethylene. A significant point: the process (which will be licensed to other lining companies) doesn't change the properties of polyethylene. It hasn't been plasticized, inhibited or extended and the applied film looks a lot like extruded or molded polyethylene.

As a plastic, polyethylene isn't a newcomer in chemical equipment applications: pipe is used extensively; sheet and film polyethylene are popular as a liner for simple equipment such

as drums and small tanks. But until now nobody had a satisfactory way to spray on polyethylene to get a bond between plastic and metal.

Polyethylene has been dip coated, but this is impractical for large equipment. Some companies have tried flame sprays before, but to get a good bond they incorporate such additives as butyl rubber or polyisobutylene. These agents change the physical characteristics and chemical resistance of polyethylene.

► **Resistant Lining**—The new method, dubbed Talicor, appears to produce a lining with the same physical properties and chemical resistance as the original polyethylene. So far the process has only been tried with the new high-density, low-pressure polyethylene, which has superior stiffness, strength, creep resistance, softening tem-

perature, and anti-stick properties (inferior to Teflon or silicon) compared to low-density, high-pressure polyethylene. But the low-density material probably can be coated when necessary.

As for chemical resistance, low-pressure polyethylene stands up to most chemicals. In general low-pressure polyethylene is resistant to alkalis and acids, except against highly oxidizing materials. You have to be careful with greases and oils since they will produce some swelling. Against solvents (room temperature) such as ethyl and methyl alcohol, xylene, naphtha, polyethylene is very satisfactory. But some aromatic and halogenated solvents will attack this plastic.

► **How They Do It**—Tank Lining Corp. is not divulging process details, except to say it involves a "very special" preparation of



They're called SERVICE ENGINEERS at Durco. When you have a tough pumping problem that is really giving you trouble, a Durco SERVICE ENGINEER is near-by.

Make your own job easier. Get the right pump in the right alloy to do the job as it should be done. Durco service engineers can help you put in the pump that will give you continuous service, with minimum maintenance, at lowest operating costs.

Durcopumps are available with heads to 345' and capacities from 1/2 to 3000 gpm in fourteen standard corrosion resisting alloys.

Durco service engineers are available almost everywhere.



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the steel surface, then flame spraying of the polyethylene, followed by a heat-treating process to insure a uniform coat.

Application and heat treating temperatures are such that there is little danger of dimensional or metallurgical effects on the steel.

The film is relatively thin, maximum economical thickness probably less than 40 mils. Most commercial applications so far are in the 8-10 mils range. At 10 mils the coating will be slightly more expensive than a thermosetting high-bake phenolic or phenolic-epoxy coating, and $\frac{1}{2}$ to $\frac{3}{4}$ the cost of most conventional sheet lining materials. Of course, as with most thin films, great care must be exercised to avoid discontinuities. Also, the coating cannot stand up under severe abrasive service.

► **High Hopes—Tank Lining** Corp. has great hopes for their process in lining large storage tanks, tank cars, ducts, blowers, sea-going tanks and barges. Right now industrial applications involving methanol and dilute HCl, (more or less test applications) include two 10-ft. lengths of 3-in. pipe, a 2-ft. x 2½-ft. storage tank, 55-gal. drums, a kettle cover, some blind flanges, an agitator and a set of baffles. A number of these units have been in operation for over six months: so far the lining is holding up very well.

Proceeding cautiously, Tank Lining offers 1 x 5 x ¼-in. or 1½ x 6 x ⅜-in. polyethylene-coated steel panels for immersion testing at \$5.00 each. For actual coating, the company quotes a figure of \$2.00/sq.ft. on equipment supplied.

New Light on Underground Corrosion

Investigations by the National Bureau of Standards into the corrosion of underground structures—spanning some 45 yr. and now bearing fruit—are producing some very practical solutions to this problem.

For instance, an extensive field-burial test program, about completed, indicates what metals and coatings should be used.

There are now in this country about 1-million miles of gas, water and oil pipelines, 170,000 miles of buried power and communication cables, an unknown number of tanks, pilings, burial vaults, and other structures. No small problem, the annual cost to the U. S. pipeline industry alone, for protective measures and replacements due directly to corrosion, is estimated at \$600-million. A still higher indirect cost results from loss of products, service shutdowns, and loss of life and property by explosion and fire due to leakage from corroded pipes. Also, since corrosion rates are often unknown, engineers have wasted large quantities of material by specifying unnecessarily large thicknesses.

Most underground corrosion is the result of electro-chemical reactions. The chief contributing factors are: moisture, oxygen and soluble salts in the soil, and the permeability of the soil to these substances.

All the plain ferrous materials show similar corrosion patterns when buried in the same soil, but the type of corrosion varies widely in different soils. In general, a high initial corrosion rate, decreasing after a few years to almost complete cessation, is found in well drained soils with high resistivities. Corrosion rate is nearly constant after the first year in poorly drained soils with low resistivities.

Data were obtained on the following low-alloy steels: copper-bearing steel, copper-molybdenum open-hearth iron, nickel-copper steels, and steels containing from 1 to 6% chromium with and without molybdenum.

Alloying elements lower the initial rate of weight loss, but



Low Maintenance on Big Al-Covered Storage Building

About 235,000 sq.ft. of corrugated aluminum siding and roofing material was used to cover this big storage building at Kaiser Aluminum & Chemical Corp.'s new Gramercy, La., plant. It holds 132,000 tons of wet bauxite ore. Designed for low maintenance, the 783-ft. long, 204-ft. wide, 83-ft. high building consists of 0.032-gage aluminum

with 1½-in. deep ribs. Each sheet weighs about 63 lb./100 sq.ft.

Ore comes in to the top of the building via a 54-in. wide conveyor line. It's dumped on the pile by a remotely-controlled reversible shuttle conveyor located at the roof ridge and running the length of the building. Recovery is made through two reclaim tunnels.



FLEXLITE ALL-DACRON FIRE HOSE



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Fire Hose did not fail**

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increase the initial rate of pitting, as compared with plain carbon steel. Except in very poorly aerated and reducing soils, however, the pitting rate diminishes more rapidly for the alloy steels than for plain steels.

Higher-alloy steels tested contained up to 18% chromium, with and without nickel and molybdenum. Increasing the chromium content causes a gradual decrease in weight loss, but pitting was accelerated by additions of chromium beyond 6%. The tendency of high concentrations of chromium to accelerate pitting appears to be neutralized by adding sufficient nickel to produce austenitic steels.

Field tests on low-alloy cast irons, containing up to 3% nickel with and without copper, show that the presence of such amounts of nickel or copper had no significant effect in any of the soils up to the amounts used. Austenitic cast irons are considerably more resistant to corrosion than plain cast iron.

Results on copper and copper alloys indicate that tough-pitch copper, deoxidized copper, copper containing up to 3% of silicon with and without tin, and red brass (15% Zn) all behave essentially alike. Soils, including cinders, with high concentrations of sulfides, chlorides, or hydrogen ions are the most corrosive toward these materials.

The corrosion rate of Cu-Zn alloys with more than 27% zinc increases approximately as the amount of zinc and was generally accompanied by dezincification—except in soils with moderate or high concentrations of sulfide. In the sulfide soils the corrosion rate decreases with greater zinc content and dezincification does not occur.

Chemical, antimonial, and tellurium lead show no appreciable differences in corrosion behavior. The corrosion rate of each tends to increase with decreasing aeration of the soil. Organic acidity is corrosive; but in soils high in sulfates, chlorides, or carbonates, the corrosion products form a protective coating.

To compare the corrosion resistance of plain iron and steels, copper, lead, and zinc, the soils were divided into 4 groups: well aerated, poorly aerated, alkaline,

and high in sulfide or sulfate.

It was found that plain iron or steel corrode much more rapidly than the other metals in all the soils except the one high in sulfate. In this soil zinc corroded more than steel; but only lead could be expected to withstand for long the corrosive action of such a soil.

In the well aerated and poorly aerated soils which are representative of most of the United States, copper has the highest corrosion resistance. This superiority is especially marked in the poorly aerated environment, where the corrosion rates of iron or steel, zinc, and lead are proportional to time. In the well aerated environment, rates of corrosion of the same metals decrease rapidly with longer periods of exposure.

Field tests on galvanized coatings over iron and steel show that a 2 oz./sq.ft. coating of zinc was sufficient protection in inorganic oxidizing soils, 3 oz./sq.ft. is needed in inorganic reducing soils, and still heavier coatings in high reducing organic soils. For steel coated with lead and copper coated with tin—both by the hot-dip process—in a great many soils the local corrosion is much deeper than the thickness of generally available commercial coatings.

Coatings of vitreous or porcelain enamel reveal no signs of deterioration in 14 years exposure. Baked phenolic coatings show marked superiority to air-dried phenolic coatings in preventing pit formation in the underlying steel. Rubber, rubber-like and bituminous coatings are also very successful, mainly because of their large thicknesses. And cathodic protection also proves to be a powerful anticorrosion tool.

Some of this work is summarized in NBS Circular 579, "Underground Corrosion," available at \$3 from Superintendent of Documents U. S. Govt. Printing Office, Wash., D. C.

Plastic Conference In Chicago

A theme of "Plastics for Profits" will be featured at the Eighth National Plastic Exposi-

tion, scheduled for Nov. 17-21, 1958, in Chicago's International Amphitheater, and sponsored by the Society of the Plastic Industry.

A technical program (Annual National Conference) is also planned, conducted by SPI, which will include talks and panel discussions on production and use of plastic materials.

On Nov. 18 panel sessions will include discussions of design trends in plastics, building code problems, and markets in the fast-growing plastic building materials field.

On Nov. 19 there will be a session on cellular plastics, including application and properties of this group of plastics.

New Aluminum Alloy Available

Availability of a new high-purity aluminum casting alloy, called X357, has been announced by Kaiser Aluminum.

The alloy combines high tensile and yield strengths with good ductility after heat treatment, plus other desirable characteristics including castability, machinability, dimensional stability and corrosion resistance. Other available alloys rate low in at least one of these qualities, thus limiting their successful application in complex casting designs. Alloy X357 is available (standard ingot sizes) at a slightly higher price over standard foundry alloys.

Primarily a aluminum-silicon-magnesium composition, the high strength is partly due to low impurities. Permanent mold properties of 52,000 psi. tensile strength, 43,000 psi. yield strength and 5% elongation have been obtained.

Promising applications include highly stressed aircraft and missile structures, high-velocity blowers and impellers and other situations where you need high-yield strengths. It is possible to reduce weight of castings, because design can include smaller cross sections without sacrificing strength. Actually X357's mechanical properties are within the range of the structural wrought-aluminum alloys 6061 and 5086.

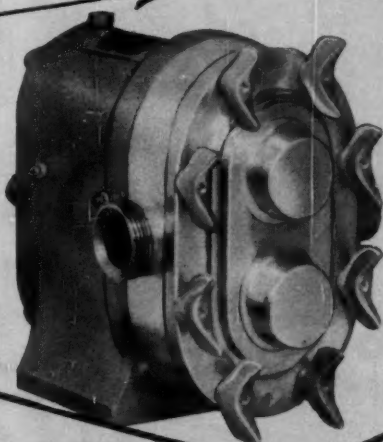
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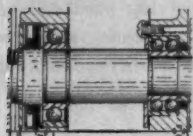
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keeps stainless steel sleeve
and shaft rotating together,
saves greatly in shaft
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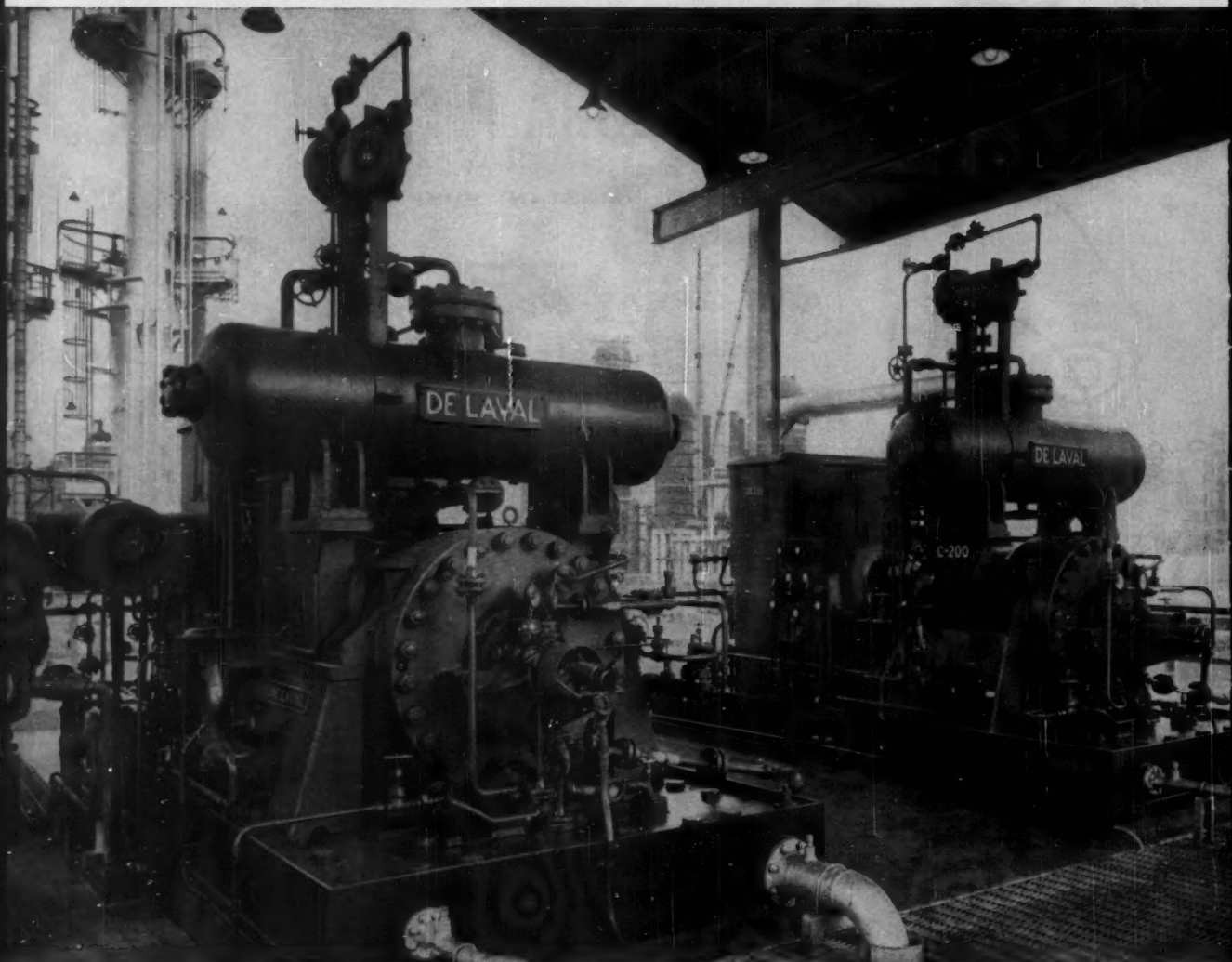
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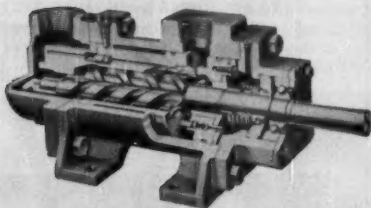
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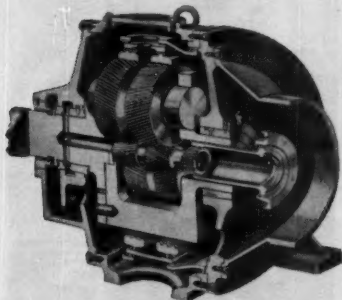
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FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES

September's Top Projects:

Standard Oil of California has OK'd final plans for its 32,000-bbl./day refinery near Honolulu. Construction will start in October and first processing units are expected to be on stream around end of 1960.

Nevada Cement Corp. has broken ground for a 500,000-bbl./yr. cement mill at Mill City, Nev. Total investment in new facility will be nearly \$3 million.

Republic Aviation is embarking on a \$35-million research program to intensify development of new aircraft, missiles and spacecraft. Major part of program will be erection of a \$14-million engineering research and development center in Farmingdale, L. I.

National Cylinder Gas Div. of Chemetron Corp. is building a \$1.8-million liquid oxygen, nitrogen and argon plant in Los Angeles, Calif.; combined capacity will exceed 30 tons/day. Production is scheduled for early 1959.

Cleaver-Brooks is starting two projects that will total almost \$2 million: 70,000-sq.-ft. addition to firm's Lebanon, Pa., plant and a new \$900,000 production facility for packaged boilers at Stratford, Ont.

Reynolds Metals Co. has completed construction on new \$70-million aluminum reduction plant at Sheffield, Ala., and work is well under way on a \$65-million expansion of adjoining alloys plant. Capacity of reduction plant is 112,500 tons/yr. primary aluminum.

Chesebrough-Pond's is planning to consolidate all domestic manufacturing operations at its Clinton, Conn., plant. A \$2.5-million expansion of the Clinton plant will allow for integration.

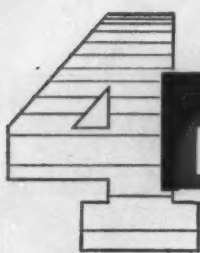
Kessler Chemical Co. has opened a second manufacturing plant

in Philadelphia, Pa. Plant, doubling firm's production capacity, will turn out glycerol monostearate, synthetic waxes, surface active agents and other fatty acid derivatives.

MacMillan & Bloedel's \$83-million expansion program at its pulp and paper mill at Port Alberni on Vancouver Island has been finished. New mill capacity is 250 tons/day market pulp, 200 tons/day kraft paper and 700 tons/day newsprint.

Arkansas Louisiana Chemical Corp. will produce chlorine and caustic soda in a plant at Pine Bluff, Ark., leased from the Army. Daily plant capacity is 75 tons chlorine and 84 tons caustic; plant was originally operated by Diamond Alkali Corp. but that firm cancelled its lease about seven months ago.

El Paso Natural Gas Co., Pacific Northwest Pipeline Corp. and Colorado Inter-State Gas Co. will join in a 540-mi. pipeline project to bring an additional 400 million cu. ft./day natural gas to California via the in-



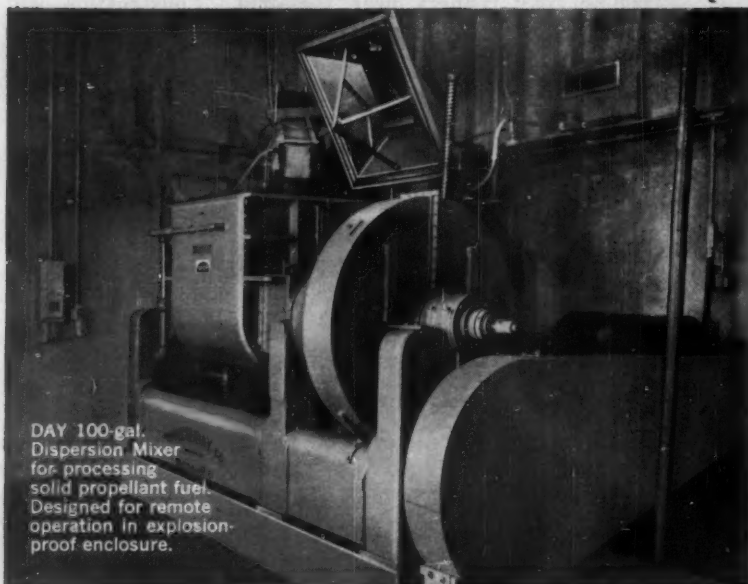
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Solid Propellant Fuel

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DAY 100-gal. Dispersion Mixer for processing solid propellant fuel. Designed for remote operation in explosion-proof enclosure.

Above is one of the four DAY Dispersion Mixers that process solid propellant at the Seymour plant of Amoco Chemicals Corp., Division of Standard Oil Company of Indiana. Amoco Engineers selected new DAY equipment because of the many unique design and construction features incorporated into these mixers for this exacting work. Typical features—

- Rugged Construction
- Tank is Stainless Steel and Jacketed
- Blades are "Z" Type and Cored
- Close Temperature Control
- Protected by Safety Devices
- Can Mix Under Vacuum
- Cover Air-Cylinder Operated
- Cover has Over-Pressure Release
- Stuffing Boxes Protect Bearings and Mixture
- Motorized Dumping Mechanism

Amoco's personnel express complete satisfaction in the safety, ruggedness and thoroughly dependable performance of these DAY Dispersion Mixers. Investigate the many proven advantages of these mixers for *your* production. Available in a complete range of laboratory and production sizes: $\frac{1}{4}$ to 300 gallon capacities, $\frac{3}{4}$ to 150 hp. drives. Write for detailed information.

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QUALITY MIXING, BLENDING, MILLING AND SIFTING MACHINES SINCE 1887
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FIRMS . . .

termountain area southwest of Las Vegas.

Vulcan Mfg., designer and builder of chemical processing equipment, is investing \$1 million in a newly acquired plant just outside Cincinnati, Ohio. Expanded plant will boast 90,000 sq. ft. manufacturing space.



Beryllium Corp. has just put nation's first privately owned integrated beryllium fabrication plant into operation at Hazelton, Pa.; facility is adjacent to firm's newly refurbished plant for production of beryllium metal. Above, operator hot-presses beryllium powder to 95% of theoretical density.

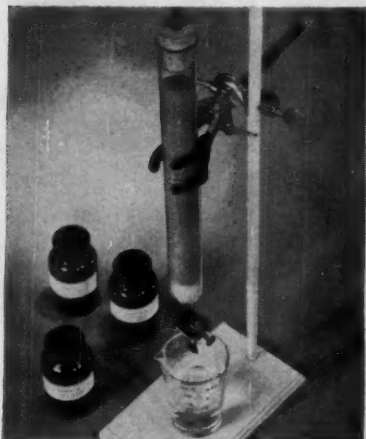
U.S. Industrial Chemicals has completed a new liquid feed premix plant at Anaheim, Calif. Unit will supply area mixer-distributors who blend liquid product with molasses for sale to beef and sheep feeders.

Grain Processing Corp., Muscatine, Iowa, has construction under way on a new wet milling corn processing plant at Muscatine. Plant will incorporate "some radical departures from long-established

"Package" ion exchange equipment for lab or pilot plant . . . from stock

Laboratory ion exchange column

The Permutit laboratory or lecture-table kit includes a 1½" O.D. glass tube with one end drawn down to fit ordinary laboratory rubber tubing, the ion exchange resin or resins required and literature describing ion exchange experiments. The user supplies the



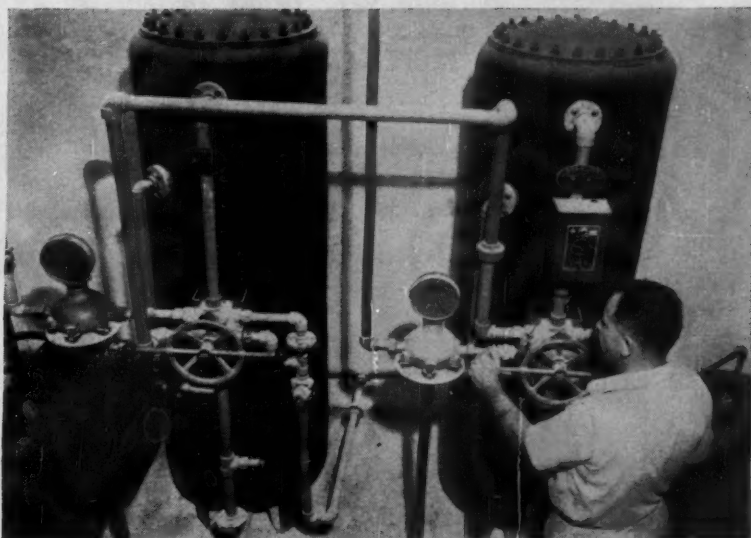
stand, clamps, tubing, stoppers and beakers. The tube will hold sufficient Permutit Q ion exchange resin to remove 20 to 25 grains of hardness.

This simple set-up is used for demonstrating ion exchange processes such as softening, dealkalinizing or demineralizing water and for experiments in removal of impurities from process solutions and separation of metals from leached ores or waste liquids.



MBD-6A mixed bed demineralizer

The MBD-6A unit (6" diam.) contains a mixture of Permutit Q cation exchange resin and Permutit S anion exchange resin. It will demineralize 1 to 2 gpm of water to a low total solids, low CO₂ and low silica content. Refills containing pre-mixed resin are available. Each refill has a capacity of approx. 1500 grains total electrolytes as CaCO₃. When the unit is exhausted, the fill may be discarded or regenerated and re-used.



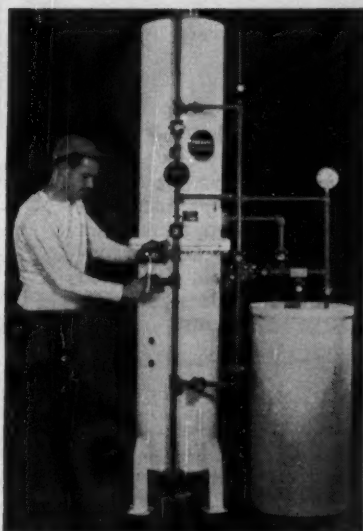
A conductivity cell is mounted in the outlet line to be used with a conductivity meter for measuring the electrolyte content of the effluent and thus indicating when the resin bed is exhausted.

Standard equipment includes the MBD-6A with initial fill, faucet adapter and hose and conductivity cell. Optional equipment: conductivity meter, resin refills and an auxiliary tube for regenerating the resins.

MBD-15 mixed bed demineralizer

This compact unit will demineralize 6 to 7½ gpm of water to an average conductivity of 0.15 micromhos (approx. 6,000,000 ohms specific resistance per cm or 0.05 ppm total electrolyte content). CO₂ will be reduced to 0.1 ppm and SiO₂ to about 0.1 ppm.

Capacity of the MBD-15 between regenerations is approx. 20,000 grains total electrolytes. For example, it will demineralize



3420 gallons of water containing 100 ppm total electrolytes or 1710 gallons containing 200 ppm total electrolytes. When the unit is exhausted, the resin bed can readily be regenerated without removing the resins from the tank. The plastic regenerating tank is used for both regenerants.

The MBD-15 is supplied piped and partially assembled and requires connecting together only 3 flanges other than the connections to influent, effluent and waste lines.

16", 24" and 30" diam. single bed units (see photo above)

Diameter of unit	16"	24"	30"
Approx. flow rate (gpm)	10	20	30

Construction of these "package" units is of the same heavy-weight materials used for Permutit's large custom-designed units and includes rugged PVC plastic interior piping and plastic strainers, full 3/16" thick rubber lining steam-cured and vulcanized to the heavy gauge steel shell. The entire lining is spark-tested at 25,000 volts. Exterior piping is high strength plastic.

Standard equipment includes a rubber-lined Permutit multiport control valve for each unit, acid pump, corrosion-proof plastic tank for cation regenerant and steel tank for anion regenerant. All parts are normally kept in stock for immediate shipment and are described in standard drawings.

For complete information, write to The Permutit Company, Dept. CE-98, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

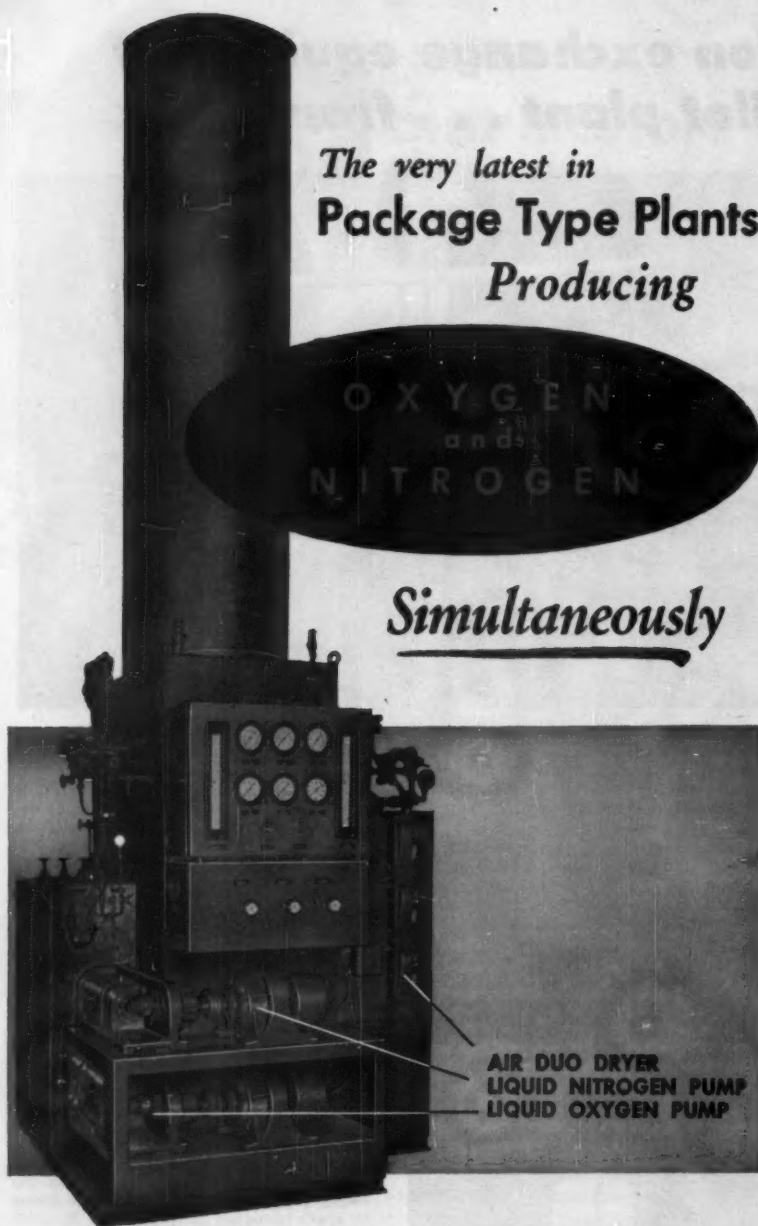
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Package Type Plants
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Simultaneously

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 LIQUID NITROGEN PUMP
 LIQUID OXYGEN PUMP

With the introduction of our latest, improved design Package Type Generating Plants, production of high purity Oxygen and Nitrogen simultaneously *increases* production 60% over the production of Oxygen alone, *plus* a corresponding reduction in the *cost* of manufacture. Due to its compact design, a minimum of floor space is required and streamlined panel assembly insures instant visibility of all control gauges. Stock sizes from 1500 to 10,000 cu. ft. per hour. Larger and smaller sizes available. 99.99% Argon available on large size plants.

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O'FALLON 7, ILLINOIS

FIRMS . . .

practices for wet milling facilities."

Air Reduction's new vinyl stearate plant at Calvert City, Ky., is now on stream. The 2-million-lb./yr. facility is the fifth Airco plant to be completed at Calvert City since 1953 and brings investment in manufacturing facilities to over \$25 million.

Tidewater has finished a 667-gal./min. water demineralizer at its Avon, Calif., refinery. Ultra-clean water, used to make high-pressure steam, will flow to boilers through special plastic and rubber-lined pipes to prevent contamination.

Union Carbide Nuclear has awarded the general construction contract for its nuclear and ore laboratories at Tuxedo, N. Y., to Joseph L. Muscarelle, Inc. Mid-1959 is target completion date.

General Electric's Silicone Products Dept. now boasts a new product development laboratory at Waterford, N. Y. Two-story brick structure houses complete equipment and services for studying new silicone gums, rubber compounds, fluids, resins and emulsions.

Air Product's new oxygen facility at Clairton, Pa., will go on stream this fall serving Clairton Works of U.S. Steel. Plant will provide 22 million cu. ft./mo. oxygen.

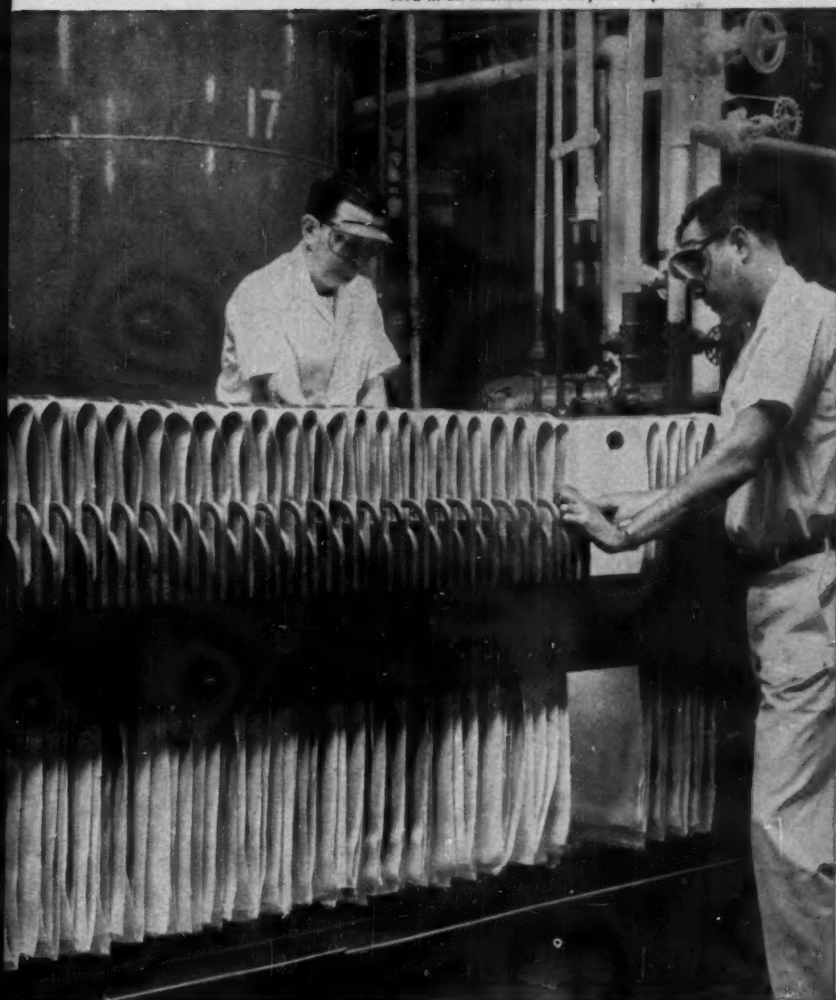
MERGERS & ACQUISITIONS

Corn Products Refining and Best Foods have reached a preliminary agreement to merge two companies. Proposal is subject to final approval of both groups of shareholders.

National Distillers purchased the Kordite Div. of Textron,

**With an
eye
on
antibiotics
and
oil
wells
Pfizer
filters
with
fabric**

30" stainless steel plate and frame filter press
used in an intermediate step in the purification of antibiotics.



A filter cloth being fabricated at Pfizer's Brooklyn "tailor shop." Wellington Sears filter fabrics are used on stainless steel plate-and-frame presses, as shown in large picture, and also on rotary filters.

Through a fabric in a filter pass antibiotics, pharmaceuticals and chemicals which may one day help save a life. Or fight the afflictions of old age. Or control a plant disease. Or—in the case of citric acid—help recover oil from "tired" wells. In the hands of specialists at Chas. Pfizer & Co., Inc., that fabric becomes an active tool in the highly successful mass production of their laboratory finds.

That a leading producer of antibiotics and other chemical products should assign the filter job to Wellington Sears fabrics is still another sign of how importantly fabric figures in industry's plans. And it is logical that organizations with first-hand understanding of research and experience should turn to Wellington Sears, to make use of more than a century of experience in serving the textile needs of industry. If you have a problem related to fabrics, in filtration, rubberizing, coating, laminating, or any combination of textiles with other materials, we'll be glad to help. And for a useful booklet, write Dept. L-9 for "Fabrics Plus," or "Filter Fabric Facts."

Wellington Sears *FIRST In Fabrics For Industry*

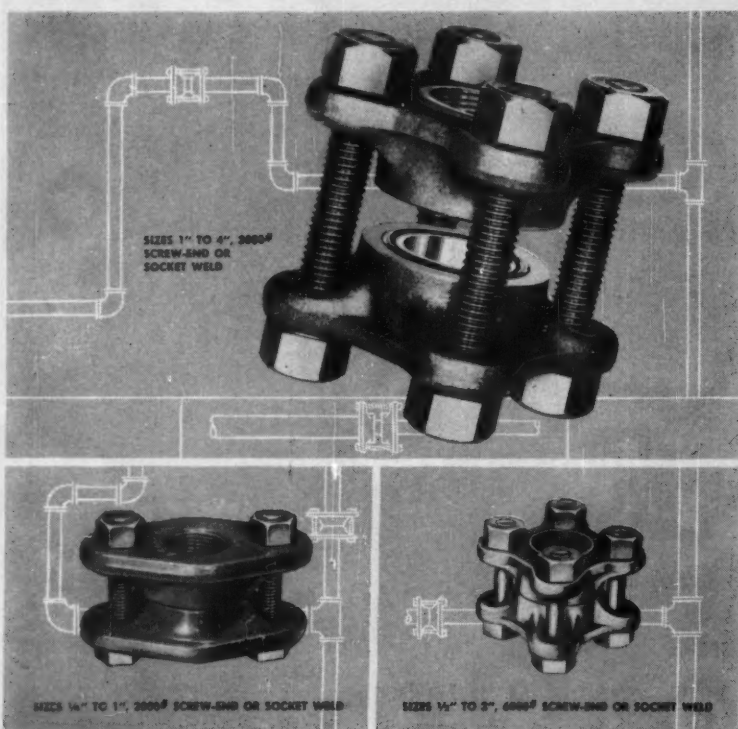


Wellington Sears Co., 111 W. 40th St., N. Y. 18, N. Y. • Atlanta • Boston • Chicago • Dallas • Detroit • Los Angeles • Philadelphia • San Francisco • St. Louis

CHEMICAL ENGINEERING—September 8, 1958

163

W-S The double diamond assures double value



Installation flexibility with permanent piping strength

GET BOTH WITH W-S O-RING FLANGE UNIONS

NOW, you can install high pressure piping systems that can easily be rearranged and adapted with full assurance that the unions will give the leak-proof service of permanent installations. This is made possible by these adaptable features of W-S O-Ring Flange Unions:

- Available in 2-bolt and 4-bolt types, according to size.
- Sizes 1/4" to 1" in 2-bolt 3000#; sizes 1" to 4" in 4-bolt type 3000#; sizes 1/2" to 3" in 4-bolt type only 6000#.
- Available in Screw-end and Socket Welding Types—3000# and 6000#.
- O-Rings available in a variety of materials for a wide range of service.

Specify forged steel W-S O-Ring Flange Unions for a tight seal against fluid pressure in piping for hydraulic machinery, refrigeration piping, steam and water lines, process liquid and gas lines, and many other applications.

For full specifications, write for Bulletin U-1-58

W-S manufactures a full range of high quality drop forged fittings, unions and couplings... in carbon, stainless and alloy steels. For full information about these products, or for your specification forging requirements, write to: W-S Fittings Works, H. K. Porter Company, Inc., Box 95, Roselle, N. J.

H. K. PORTER COMPANY, INC.

FORGE AND FITTINGS DIVISION

W-S Fittings Works, Roselle, N. J. • Cleveland Forge Works, Cleveland 4, Ohio
Stainless Steel Works, Duncannon, Pa.

FIRMS . . .

Inc., for undisclosed amount of cash. Kordite, an integrated converter of plastic packaging materials, will operate as an independent subsidiary of National.

Permanente Cement Co. now owns controlling interest in the Olympic Portland Cement Co. Olympic's plant at Bellingham, Wash., has an annual capacity of 1.75 million bbl. cement.

Permutit Div. of Pfaudler Permutit announces acquisition of the flotation equipment business owned by Bulkley-Dunton Pulp Co. Purchase includes trade mark and manufacturing rights for Colloidair separator used for clarifying waste process liquids.

Glidden Co. is transferring its Chemurgy Div. to Central Soya Co., Fort Wayne, Ind. Chemurgy Div. has soybean processing operations in Chicago and Indianapolis plus other storage facilities.

Chas. Pfizer & Co. has purchased from the Federal Government a pharmaceutical plant south of Terre Haute, Ind., that Pfizer has operated on a lease basis since 1947. Included in purchase are fermentation facilities for making streptomycin, Terramycin and other antibiotics.



Marbon Chemical is relocating its general sales office, research laboratories and general administrative center adjacent to new Woodmar plant at Washington, W. Va.

General Aniline & Film has transferred a major section of its Dyestuff & Chemical Div. research operations to company's central research laboratory in Easton, Pa.

NEW COMPANIES

Titanium Metals Corp. of America is expanding its operations to Europe with formation of a jointly owned titanium company with Deutsche Edelstahlwerke (DEW), Germany's leading specialty steel producer. New company, Continental Titanium Metals Corp. will be headquartered in Luxembourg, while production will be centered in DEW's 7,000-man plant in Krefeld.

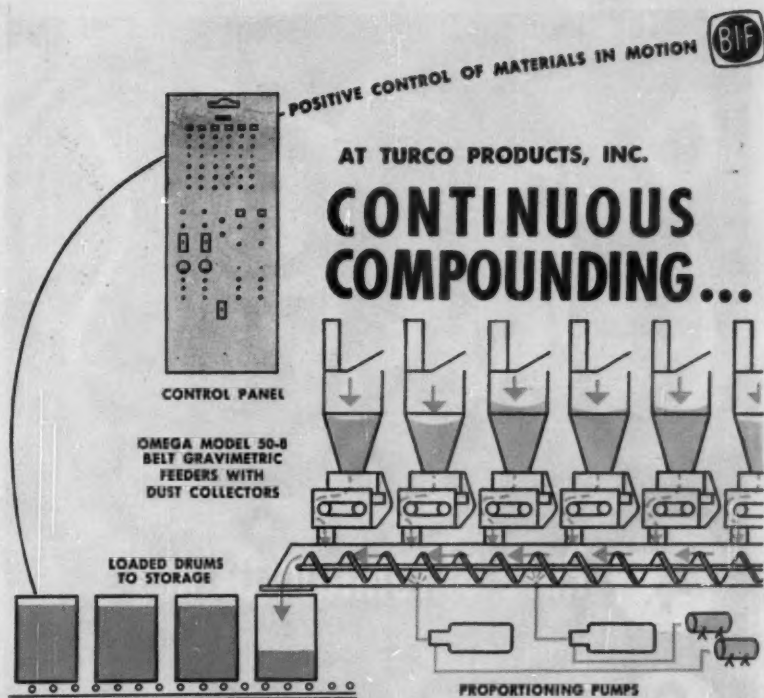
Olin Mathieson has joined with four foreign corporations in a venture to develop vast bauxite deposits in French West Africa at an estimated total cost of \$135 million. Other companies are: Aluminium Ltd. (Britain); Pechiney and Ugine Companies (France) and Aluminium Industrie Aktiengesellschaft (Switzerland). Olin Mathieson owns 53.5% of the company by virtue of its \$21-million capital investment.

Walter E. Lobo, formerly with consulting firm of Devys & Lobo, now has organized own consulting firm with offices in New York City.

W. R. Grace has formed a new subsidiary, Grace Electronic Chemicals, to act as sales representative in U.S. for ultra-high-purity silicon coming from a new plant in Puerto Rico jointly owned by Grace and Pechiney (France).

General Mills and Britain's Savage Ampersan Parsons, Ltd., are in final stages of forming a jointly owned company to design and market remote control handling equipment for radioactive materials.

Callery Chemical, Thiokol Chemical and General Motors have entered into a working agreement "aimed at developing advanced devices in the field of guided missiles and space travel."



... with **OMEGA FEEDERS** provides positive quality control, high production at low cost, maximum production flexibility

This compact line of Omega Belt Gravimetric Feeders controls the formulation of over two-hundred different cleaning and process chemicals and rust preventives. Dry chemicals are proportioned with liquid chemicals, dye and perfume fed by Proportioners Pumps. Because of the Omega Feeders' high accuracy ($\pm 1\%$ by weight) and wide range (100:1), the compounding system produces high quality products and permits maximum production flexibility at lowest direct labor cost.

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Omega offers a full line of process-engineered feeders — for dry and liquid materials — volumetric and gravimetric. Bulletin 10-N1 gives complete details. For your copy, write **Omega Machine Co., Process Application Department, 369 Harris Ave., Providence 1, R. I.**

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CALENDAR

Technical Assn. of the Pulp and Paper Industry, 3rd International Mechanical Pulping Conference, Chateau Frontenac, Sept. 10-12 Quebec, Que.

Society of Plastics Engineers, Technical conference: Plastics in Automotive Application, St. Clair Inn, Sept. 12-13 St. Clair, Mich.

Society of Chemical Industry, travelling conference to view Canadian industry, starts at Chateau Frontenac, Sept. 11-23 Quebec, Que.

Instrument Society of America, 13th annual Instrument - Automation Conference, Convention Hall, Sept. 15-19 Philadelphia, Pa.

Canadian Agricultural Chemicals Assn., 6th annual meeting and conference, Fort Garry Hotel, Sept. 15-17 Winnipeg, Manitoba

Technical Assn. of the Pulp and Paper Industry, 3rd International Fundamental Research Symposium, Queen Elizabeth Hotel, Sept. 15-17 Montreal, P. Q.

American Institute of Chemical Engineers, national meeting, Sept. 21-24 Salt Lake City, Utah

Technical Assn. of the Pulp and Paper Industry, 12th Alkaline Pulping Conference, Arlington Hotel, Sept. 24-26 Hot Springs, Ark.

Chemical Market Research Assn., market research conference, French-Lick-Sheraton Hotel, Sept. 24-26 French Lick, Indiana

Technical Assn. of the Pulp and Paper Industry, 9th Paper Testing Conference, Oglethorpe Hotel, Sept. 30-Oct. 2 Savannah, Ga.

Society of Plastics Engineers, New England Section, regional technical conference, Statler-Hilton Hotel, Oct. 1 Hartford, Conn.

American Institute of Chemical Engineers, South Texas Section, 13th annual technical meeting, Moody Center, Oct. 3 Galveston, Texas

National Assn. of Corrosion Engineers, Northeast Region, regional conference, Oct. 6-8 Boston, Mass.

American Society of Mechanical Engineers-American Society of Lubrication Engineers, Lubrication Conference, Statler Hotel, Oct. 13-15 Los Angeles, Calif.

Society of Industrial Packaging and Materials Handling Engineers, annual national exposition, Coliseum, Oct. 14-16 Chicago, Ill.

American Institute of Chemical Engineers, New York Section; all-day symposium: Cost Engineering, Trade Secrets & Patents, Petrochemicals, Fermentation; Hotel Statler, October 23 New York, N. Y.



LINDE SELECTED GRAVER To Build These Liquid Oxygen Storage Spheres

To keep oxygen liquid—at 297° below zero—for prolonged periods, requires quality fabrication of the container. Otherwise, losses from heat-leak, and consequent evaporation, would increase oxygen cost.

To meet these severe requirements in fabrication, Linde Company (Div. of Union Carbide), a leading producer and shipper of liquid oxygen, chose Graver to fabricate these 9 ft. diameter, double-shell spheres. The inner shells are constructed of 304 stainless steel, and the outer jackets of carbon steel. Insulation is by Linde-patented powder-vacuum. Fabricated with air-tight

welding to assure holding the vacuum between the shells, the spheres were delivered complete with instruments ready for installation.

The fabricating and welding skills in these liquid oxygen spheres are the result of many years of experience. Graver's extensive background in the field of cryogenics is but one of the many reasons why companies regularly turn to Graver to fabricate storage and processing vessels in alloys and carbon steels—especially those calling for the special skills required for quality production to meet severe operating conditions.

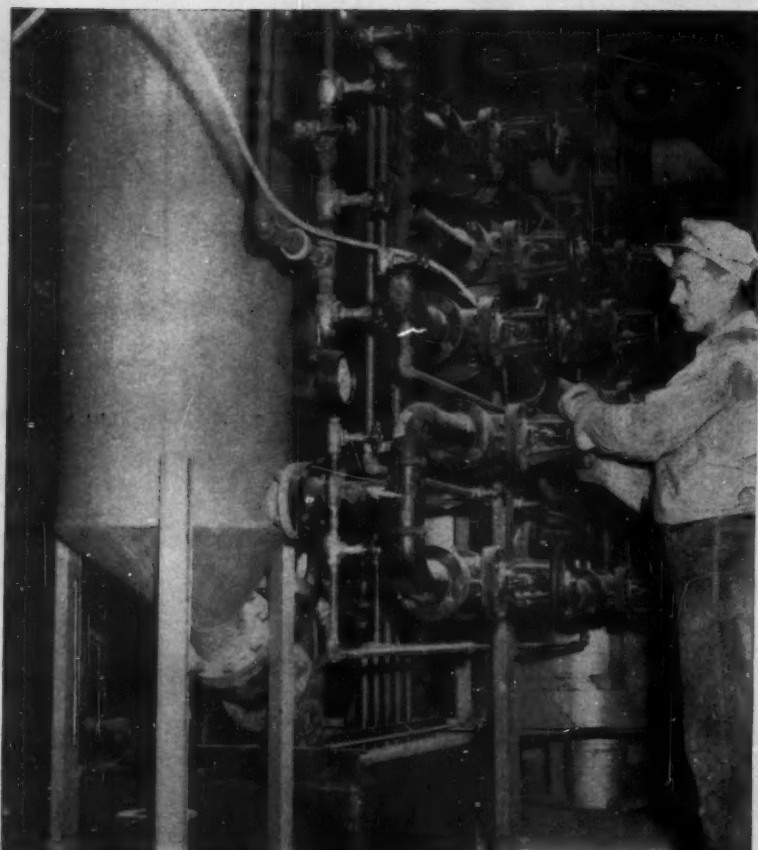
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ALLOY DIVISION

*Building for the Future on
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Successfully operating for over a year in the revolutionary new Unit 6 of the Philo Plant of Ohio Power Co., this Croll Reynolds ClaRite feedwater filter using SOLKA-FLOC filter aid has fully borne out its extensive pilot test predictions.

In feedwater purification— iron oxide cut from 200 to 1 ppb with SOLKA®-FLOC Filter Aid

The problem: Purifying feedwater condensate in the first commercial super-critical pressure steam generating plant.

The solution: Pre-filtration of the demineralizer influent to prevent rapid fouling caused by minimum amounts of suspended iron oxide. Extensive pilot tests proved that a filter station using SOLKA-FLOC, followed by a cation resin bed, cut feedwater iron oxide from up to 200 parts to one part per billion.

Whether your field is water purification, or whether it is heavy chemicals, food processing, pharmaceuticals, chromatography, beverages, textiles, plastics, stream pollution, or a long

list of others, you can benefit from this versatile filter aid.

SOLKA-FLOC is economical, highly purified, finely divided cellulose. Besides improving filtration rates, it keeps screens cleaner, saves downtime, gives you more economical volume of clarified filtrate with minimum retention of filtrate in the cake.

Added advantages: It makes a stable pre-coat, does not bleed, prevents loss of cake from pressure drops, does not abrade pumps and valves. And SOLKA-FLOC adsorbs many metals such as iron, copper, other impurities.

Write us about your specific filtration problems. Address Dept. DF9, our Boston office.

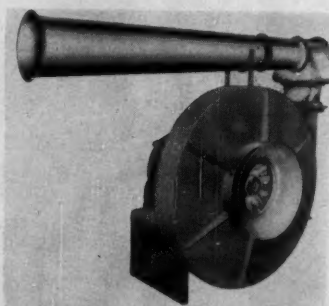
BROWN COMPANY

General Sales Offices: 150 Causeway Street, Boston 14, Mass. Mills: Berlin and Gorham, N.H.
Sold in Canada by Brown Forest Products, Ltd., Montreal, Que. (ALPHA-FLOC)

NEW EQUIPMENT . . .

(Continued from p. 82)

units have a baked-enamel finish. Front, side and rear panels readily detach for quick access to the instrument terminals and adjustments. — Cleveland Controls, Inc., Cleveland, Ohio. 82C



Pneumatic Conveyor

No moving parts exposed to materials handled.

For bulk transfer of granular solids from one or more points to any collection area, the new Quickdraft materials-handling unit utilizes a unique system for protection of moving parts. To develop required vacuums, a high-pressure blower exhausts through a venturi orifice to an expanding delivery tube. This setup eliminates exposure of blower, motor and bearings to materials being handled.

Quickdraft exhausters come in Type 316 stainless and coated steels, plastic and acid-resisting vitreous enamel. Several models, for line diameters ranging from 6 to 30 in.—Quickdraft Corp., Canton, Ohio. 168A

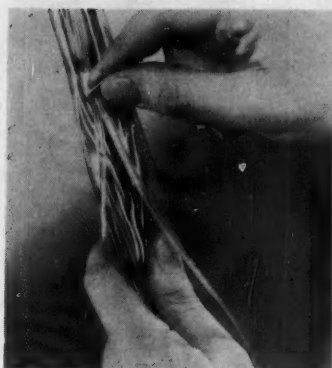
Particle Accelerator

Available for study of nuclear structure.

Known as the Tandem Van de Graff, a new high-energy nuclear particle accelerator constitutes a major advance in techniques for nuclear structure studies. The first unit, built for Atomic Energy of Canada, Ltd., has accelerated protons to an energy of about 13 Mev., oxygen nuclei to 30 Mev.—and at energy precisions of better than 0.1%. Construction is

now underway on two additional machines.

In operation, negative ions, accelerated to the positive terminal of a double insulating column, lose electrons as they pass through a low-pressure gas. The ions, now positive, then accelerate through the second half of the column, thus receiving an over-all energy of twice that from a single acceleration.—High Voltage Engineering Corp., Burlington, Mass. 68B



Zippered Cable Cover

Simplifies wiring installation and maintenance.

Combination of a slide fastener with an extruded vinyl plastic forms a unique, flexible housing for wire and cable. Compared to conventional sleeving, the product makes it much easier to expose wiring trouble areas for all types of maintenance—substantial savings in time and labor are the result. The new housing offers excellent dielectric properties, and is inherently waterproof.—Alpha Wire Corp., New York. 169A

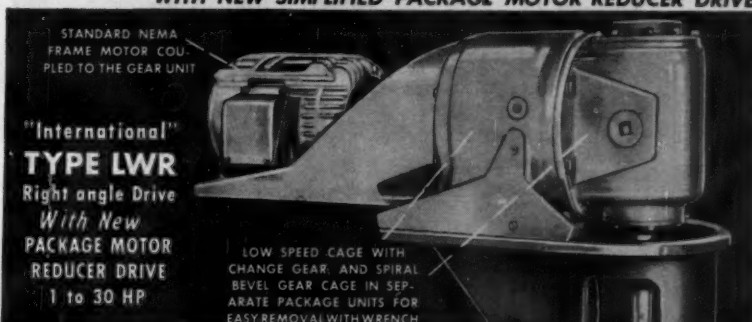
Fractionator Computer

Useful as operational aid or for automatic control.

Accepting electrical input signals such as flow rate and product analysis from standard instrument transmitters, a new analog computer can perform computations designed to maintain fractionator products at desired quality or quantity. The

International Slow Speed Mixers

WITH NEW SIMPLIFIED PACKAGE MOTOR REDUCER DRIVE



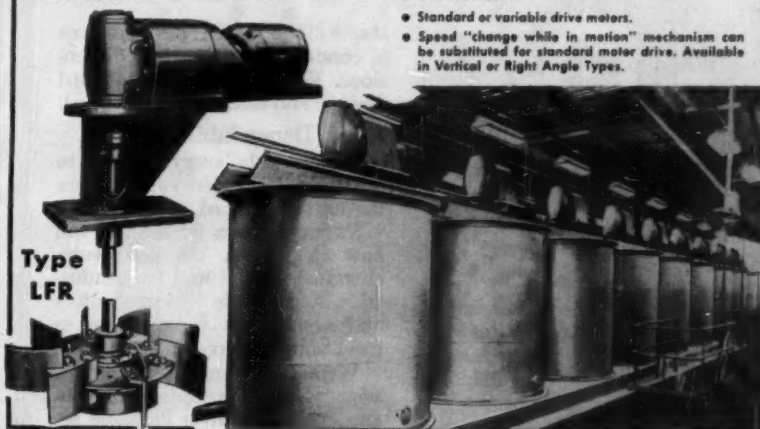
IN VERTICAL AND RIGHT ANGLE TYPES—"International" Package Reducers and Integral Gear Motors provide a brand new, economical and practical answer to most of the problems of Mixer Drive-Head operations. Ratio changes are made in the High Speed Gear Set, ahead of the low speed set, both of which are assembled into a rigid cast iron cage. This subassembly is a complete unit, with gears and bearings, providing easy removal and accessibility.

COMPLETELY INTERCHANGEABLE

No special tools or machine operations required for gear ratio change. Standardized parts provide quick change and low maintenance. Vertical mixer shaft speeds from 1.8 RPM to 230 RPM. HP range from 1 to 30. Uses any standard motor. Long span between bearings insures mixer shaft rigidity. Quiet operation because of ground tooth gears. SPLINED SHAFTS and GEARS provide positive ratio change of gears. Ample overhung load capacity. Positive lubrication. Positive Mechanical Type Oil Seal. Drive head furnished with or without a welded pedestal. Particularly adapted to Turbine operation. Highest Mechanical Efficiency. Ask for Special Bulletin.

International — Type LFR — SLOW SPEED

- Uses any standard motor, Low Head room.
- Mechanical efficiency 96 to 98 1/2 %.
- Speed ranges 1 to 350 RPM.
- Interchangeable speeds.
- All steel gear housing—unbreakable.
- Wide bearing spans increase shaft rigidity.
- Quiet in operation. AGMA ratings.
- 100% starting and momentary overloads.
- Closed or open vessel operation.
- 1 to 100 H.P.
- Standard or variable drive motors.
- Speed "change while in motion" mechanism can be substituted for standard motor drive. Available in Vertical or Right Angle Types.



Type "LFR"—9 unit installation 5 HP Agitated Storage Tanks

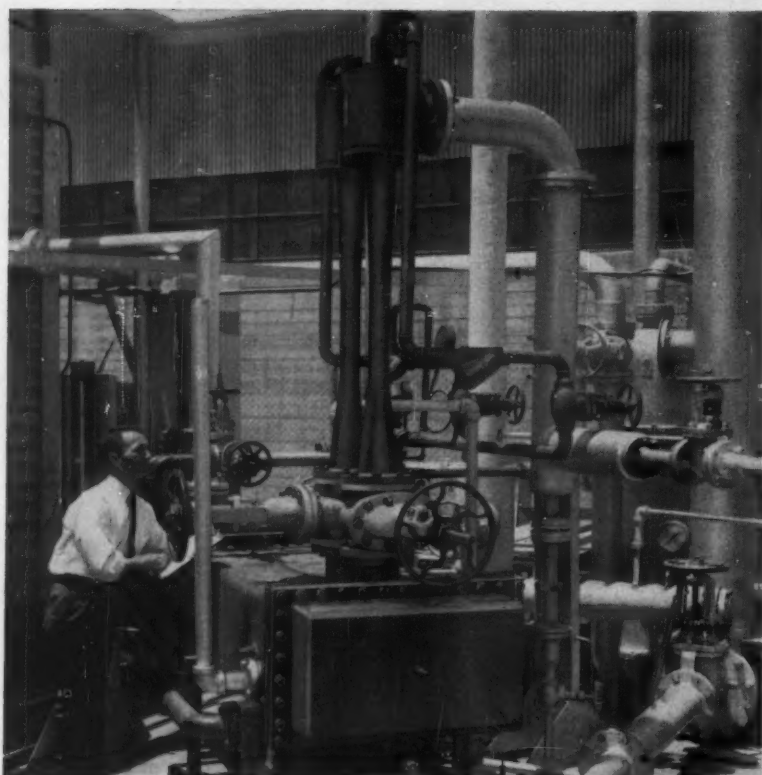
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Steam jet ejectors offer important capital and operating economies in producing vacuum for your process. SWECO's application engineers thoroughly study your vacuum requirements and utilities, to arrive at the optimum balance between initial cost, installation cost, and operating cost.

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SWECO's staff of ejector and condenser specialists pool their talents and experience to engineer the best unit for your particular vacuum application... the right materials... the right number of

stages... the right types and sizes of condensers... the right dimensions. Where practical, standard designs and components are used.

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Write today and let us know of your vacuum equipment needs. Our catalog, with a valuable set of Dalton's Law Charts is also available on request. Ask for Data File M-10-32.



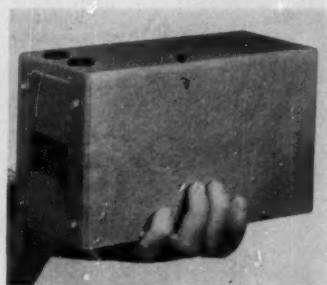
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Engineers & Constructors... Manufacturers

NEW EQUIPMENT . . .

first unit delivered now computes tower performance for operator guidance; however, applications as optimizing controllers are future probabilities.

Elimination of all vacuum tubes, relays and servo-slide-wires assures extremely high reliability. Safe for explosive areas, the unit is enclosed within a moisture-proof cabinet.—Southwestern Industrial Electronics Co., Houston, Tex. 169B



Voltage Regulators

Only 10% of weight and size of conventional units.

Low cost, small size and weight, and excellent electrical characteristics make the Claude Lyons automatic line-voltage regulator an ideal item for instrument panels, controlled-speed machinery and computers. Despite a size and weight only 10% that of conventional units, the regulators are completely independent of load from 0-100% of rated value. Likewise, input frequency variations from 45-65 cps. have no affect. Correction generally occurs within 3 cycles.

Available for single- or 3-phase inputs of 115 or 230 v., models come with outputs varying from 575 to 2,300 va.—British Industries Corp., Port Washington, N. Y. 170A

Plastic Ladder

Designed especially for chemical industries.

Made of molded glass-fiber plastic with a balsa wood core, a new chemically resistant ladder is claimed by the manufacturer to be the toughest and most durable ladder ever con-

structed from any material. For added safety, the aluminum rungs molded into the side pieces feature a non-slip, grit-embedded neoprene covering.

Since 120,000 v. applied between the rungs causes no breakdown, the ladders are considered safe for electrical repair work.—Putnam Rolling Ladder Co., New York. 170B



Detachable-Bin Truck

Maximum handling capacity greatly increased.

Featuring container capacities to 40 cu. yd., legal over-the-road load limits to 30,000 lb. and unlimited off-the-road capacities, the new Dempster-Dinosaur is of extremely simple design. Components include the truck cab, detachable container, hydraulically actuated tilting frame and a hydraulic bail cylinder. In operation, the bail cylinder pulls containers up the tilting frame with a ratcheting action against a set of recessed retaining hooks.

The manufacturer believes that the new unit will find greatest application for accumulation and removal of plant waste materials such as spent catalyst, used insulation and general trash. However, tank- and cargo-type containers for liquid or solid raw materials and products are under development.—Dempster Brothers, Knoxville, Tenn. 171A

Stainless Steel Pumps

Two new pumps offered for corrosion service.

Featuring Type 20 stainless steel construction, a new line of centrifugal pumps offers a variety of capacities: from 56

We Sell Filtration

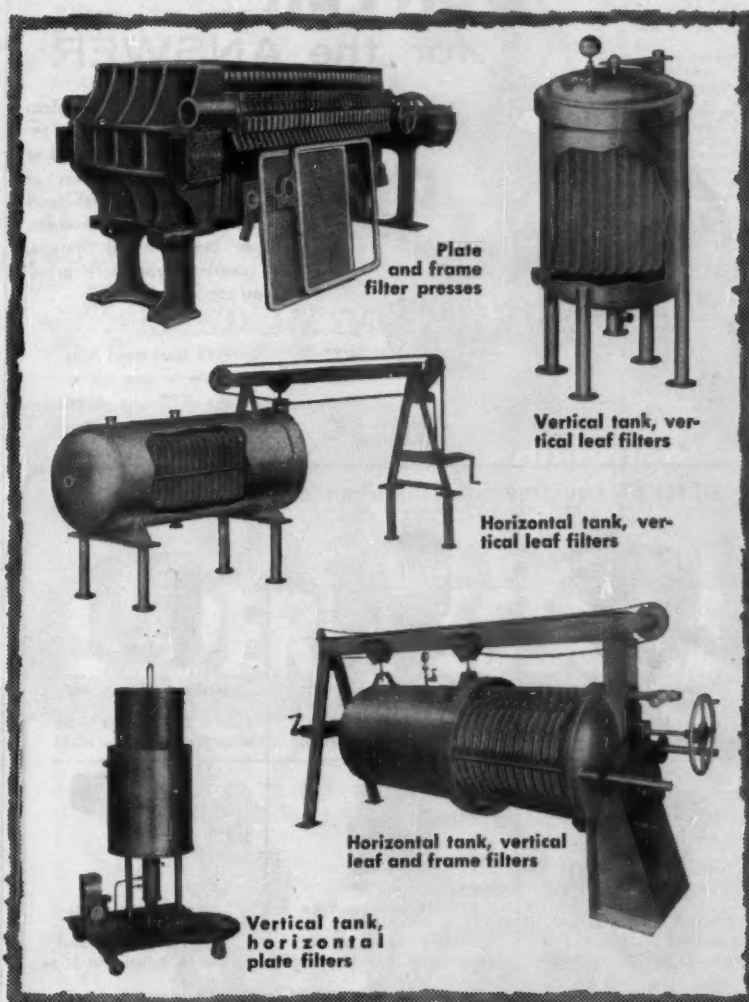
NOT THE FILTER

At Shriver's we recommend the filter that's *right* for the specific processing conditions. This is done without prejudice or bias.

Of course, we design and manufacture an extensive line of pressure filters, suitable for a large majority of applications, but if our careful study of your filtration problem shows you need a vacuum filter or a pressure filter we do not manufacture, we tell you so frankly. Our aim: your satisfaction.

It's that simple, and has been paying off in customer goodwill for many years. We hope to continue meriting industry's confidence.

Literature on Shriver filtration equipment shown here will be gladly sent on request.



T. SHRIVER & COMPANY, INC.

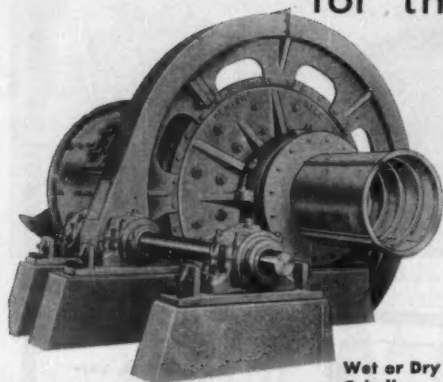
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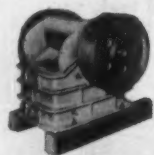


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DENVER Steel Head Mills available in sizes up to 10' dia. x 20' long. Write for Bulletin No. 82-820.

DENVER Equipment for the Chemical Process Industries



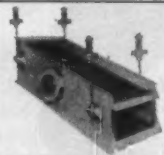
DENVER Jaw Crushers
Sizes from 2 1/4" x 3 1/2" to 32" x 40"
Write for Bulletin No. C12-B12



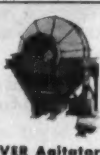
DENVER SRL Pumps
Capacity to 3000 g.p.m.
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DENVER Agitators and Mixers
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8" to 120" Cutter Travel
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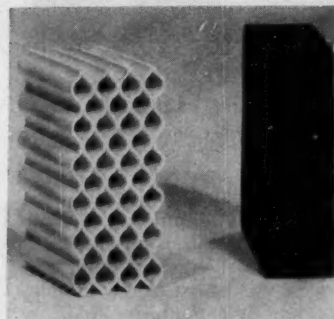
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NEW EQUIPMENT . . .

gpm. at no head, to 75 gpm. at 90 ft. head. Stationary seats, which are normally faced with ceramic material, also come in Stellite for caustic service. All mechanical seals are corrosion resistant; rotary faces of pure carbon or glass-filled Teflon can be supplied.

Another new pump, designed to prevent product contamination, features all 316 stainless construction other than the neoprene impeller. Self-priming, the pumps handle either 10 or 25 gpm. Limiting temperature range is 35-150 F.—American Machine Products, Inc., New York, N. Y. 171B



Corrugated Ceramics

New degree of freedom in ceramic technology.

Recently developed techniques now make it possible to fashion ceramic materials into extremely thin corrugated shapes or other high-surface-area structures. Rolling and many forming operations, heretofore limited to ductile metals, are now applicable, through an undisclosed process, to ceramics. In final form, however, the ceramics are no longer ductile. Photo above shows typical forms; from left to right, the structures pictured have 3 and 7 corrugations per inch, respectively.

Probable end uses for the honeycomb structures will include incorporation into high-temperature heat exchangers, applications as catalyst supports, and as lightweight structural elements. — Minnesota Mining & Mfg. Co., St. Paul, Minn. 172A

BRIEFS

Vertical plate filter, available with filtering areas up to 1,000 sq. ft., features Monel elements particularly suited to caustic solutions. A spray sluicing system removes the cake. — Sparkler Mfg. Co., Mundelein, Ill. 173A

Pneumatic tank truck for weatherproof shipment of powdered products has an effective pumping range of 150 ft. With an 800-cu. ft. capacity, unit unloads cement at about 35 tons/hr. — Delta Tank Mfg. Co., Baton Rouge, La. 173B

Cryogenic tank-in-boxcar for transporting liquefied gases by rail has a liquid equivalent capacity of 1-million cu. ft. (NTP) oxygen. Claimed to hold annual maintenance bills to 1/100 of initial car cost. Licensing agreement. — Linde Co., New York. 173C

Oil circulator maintains controlled volume and pressure of oil feeding to stuffing boxes and bearings. Complete with 18-gal. tank, pump, motor and controls. — Durametallic Corp., Kalamazoo, Mich. 173D

Disc filters, constructed for working pressures of 3,000 psi., come in five sizes ranging from 1.5 gpm. at 3 psi. pressure drop to 47.6 gpm. at 6 psi. (for 100 SSU oil). Laminated fiber discs. — Wm. W. Nugent & Co., Inc., Skokie, Ill. 173E

Speed reducer line now includes a quadruple-reduction helical gear drive. Available in five sizes, the unit ups possible reduction ratio to 2,217:1. — Link-Belt Co., Chicago. 173F

Plastic gloves, packed in convenient rolls of up to 1,000 gloves each, cost only 3 cents per glove. Made of 14-mil polyethylene, they are pre-lubricated for ease of hand insertion. — PlasticSmith, Inc., Concord, Calif. 173G

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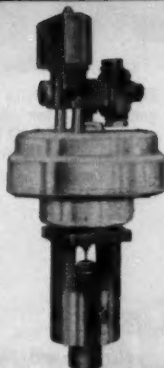
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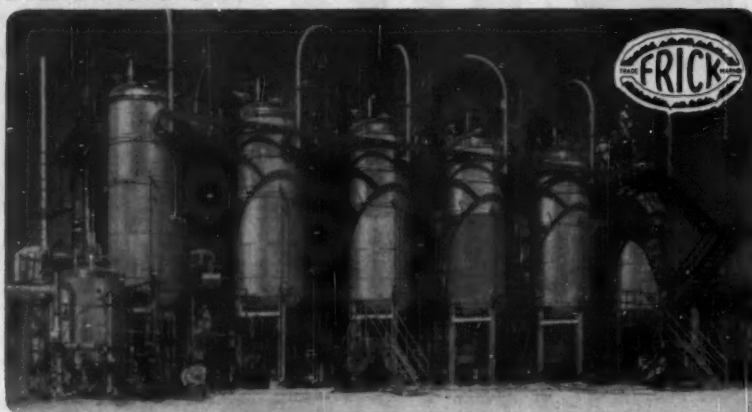
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NEW



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Frick Company furnished the twelve big reactors* illustrated, each 22 ft. high and equipped with a double set of Frick cooling coils*; plus coolers and evaporative condensers for butadiene, evaporative condensers for ammonia, and numerous auxiliaries.

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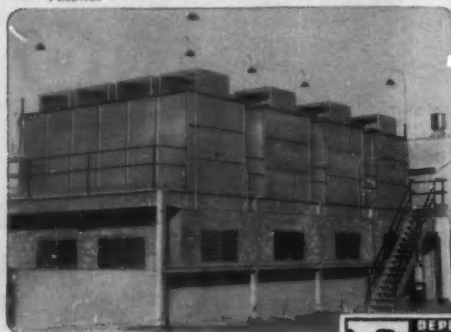
Thus another great synthetic plant joins the list of firms using Frick cooling equipment.

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NEW EQUIPMENT . . .

flows to 2,300 cc./hr. at discharge pressures of 1,000 psig., and 1,040 ml./hr. at 2,000 psig. Another pump, actuated by electrical signals, delivers to 1.5 gpm.—Lapp Insulator, Le Roy, N. Y. 173H

Centrifugal pump line incorporates API specifications together with maximum interchangeability of parts. Capacities range from 25 to 1,000 gpm.; heads to 650 ft.—Dean Brothers Pumps, Inc., Indianapolis, Ind. 174A

Portable cooling-coil package for temperatures down to 5 F. includes a complete refrigeration system, operable from a standard 115-v. a.c. supply. Thermostatic control accuracy is ± 2 deg.—Andrew Technical Supply Co., Chicago, Ill. 174B

Equipment Cost Indexes . . .

	March 1958	June 1958
Industry		
Avg. of all.....	231.2	230.7
Process Industries		
Cement mfg.....	222.9	222.2
Chemical.....	232.4	231.7
Clay products.....	216.6	216.0
Glass mfg.....	219.4	218.8
Paint mfg.....	223.8	223.1
Paper mfg.....	223.9	223.3
Petroleum ind.....	228.6	227.9
Rubber ind.....	231.4	230.7
Process ind. avg...	228.8	228.2
Related Industries		
Elec. power equip....	234.2	234.3
Mining, milling.....	233.8	233.1
Refrigerating.....	261.5	260.7
Steam power.....	219.5	218.4

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 125-6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143-4 for annual averages since 1913.

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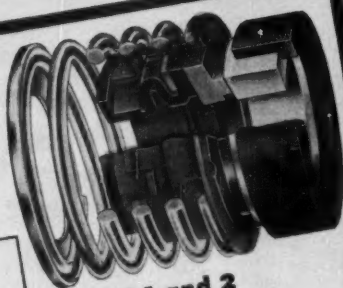


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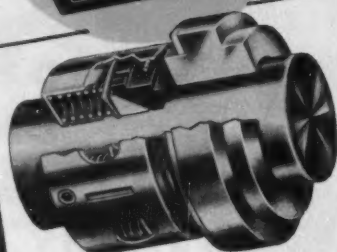
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TECHNICAL

Prelude to More Study

GAS DYNAMICS. By Ali Bulent Cambel and Burgess H. Jennings. McGraw-Hill Book Co., New York. 415 pages. \$11.

Reviewed by Alexander Weir, Jr., Atlas Program Office, Space Technology Laboratories division of Ramo-Wooldridge Corp., Los Angeles, Calif.

This book combines in one volume material on thermodynamics and thermochemistry, reaction kinetics, one dimensional and potential flow theories of aerodynamics, combustion, dimensional analysis, measurement techniques, and elementary shock wave theories.

Broad scope of the work necessarily limits the depth of treatment. For example, Liepmann and Roshko in their "Elements of Gas Dynamics" present characteristic (t-x) diagrams of shock tubes while Cambel and Jennings do not discuss the shock tube at all. The existence of Mach discs in supersonic jets is ignored and the Prandtl-Meyer expansion is not discussed.

Treatment of combustion, to which about three of the thirteen chapters are devoted, is also shallow when compared to "Combustion Processes," or to other books in the field. Less than one paragraph is devoted to the role of C_2 and CH radicals in combustion. Combustion processes using oxidizers other than air are not discussed in much more detail and the presentation of flame stabilization studies, to which a great deal of the combustion discussion is devoted, is incomplete.

Similar comparison could be made between the thermodynamic material presented in this book and that contained in texts devoted to the subject, or between the material presented in the chapter entitled Experimental Techniques and Measurements and that contained in "Physical Measurements in Gas Dynamics and Combustion." Supersonic combustion or detona-

BOOKSHELF

J. B. BACON

tion phenomena and hypersonic flow problems are barely discussed while newer areas of interest such as magneto-hydrodynamics are not discussed at all.

This reviewer would not recommend this book for specialists in aerodynamics or combustion or thermodynamics because of the limited treatment these subjects receive. However, the inclusion of all of the subjects in one book makes it valuable to the engineer who does not wish to purchase the four or five books to cover the subjects adequately.

Chemical engineers who are interested in an introduction to high velocity flow or combustion problems will find the material easy to follow and can use the bibliography at the end of the later chapters for more extensive study if desired. Since the book is intended for a text as well as a reference book, problems are included at the end of each of the thirteen chapters.

Fifty pages of aero and thermodynamic tables are included in the appendix and the text includes a number of excellent interferograms and Schlieren photographs.

BRIEFLY NOTED

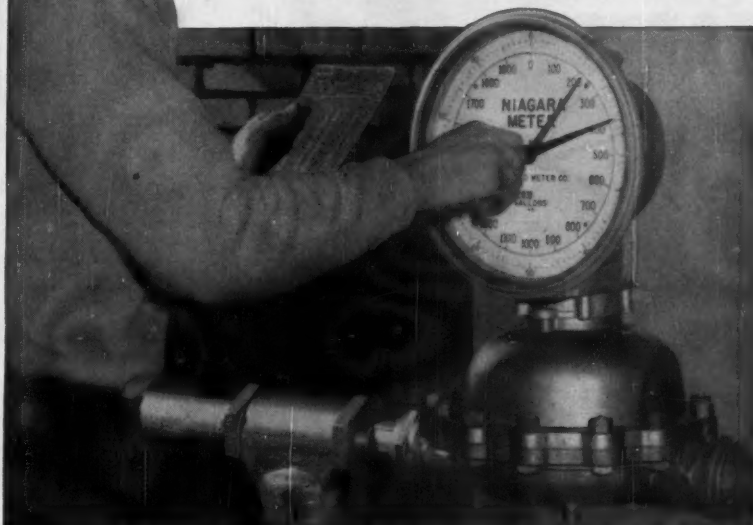
DEVELOPMENT AND EVALUATION OF INSULATING-TYPE CERAMIC COATINGS, PART 1—DEVELOPMENT AND SMALL-SCALE TESTING. 98 pp. By S. Sklarew, C. A. Hauck and A. V. Levy, Marquardt Aircraft Co. for Wright Air Development Center. Order PB 131434 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. \$2.50. Reports investigation of eight metal-reinforced refractory coatings effective in 2,000-3,000 F. range.

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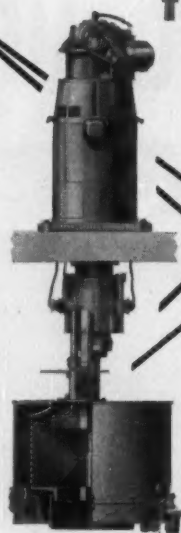
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LETTERS:



More on Inside Insulation

Sir:

In your Plant Notebook article, "Inside Insulation Saves Cost" (May 5, p. 148), an important fact was omitted.

This is that condensation is very likely to form on the inner surface of the outer pipe. Possibly this is why inside insulation is not used more in the U.S.

In the example given, the 1,400 F. air at 850 psia. would have to have a dewpoint well below the outside design temperature of 150 F. to prevent condensation on the inside of the outer pipe.

With most hot gases a great risk would be taken to use such ducts to prevent heat loss. Exposure to winter winds will undoubtedly cause a wet, corrosive mass of insulation to form inside the pipe. With the sulfur and fluorine found in most hot gases, the outside pipe would have a very short life.

J. W. LENEHAN
New Brunswick, N. J.

Two M's or Not Two M's

Sir:

I generally count myself in the group believing that spellings listed by Webster are acceptable (referring to Mr. Dean's letter, July 14, p. 181), though I am opposed to the objectives of his committee for giving editors freedom to spell as they please.

Mr. Dean failed to mention the rules, found in standard reference works, regarding doubling

PRO & CON

C. H. CHILTON

of final consonants. They all agree on the doubling of the final single consonant in monosyllables and words accented on the last syllable, but not on words accented on earlier syllables. Doubling of the final *m*, according to this rule, would give the unwary reader the false impression that the word *program* is accented on the second syllable.

However, upon consideration of Webster's treatment, particularly his single entry for *programmer*, I'm inclined to forget the rule in this instance and let the editor do as he pleases. There is a shadow in the background of the variant spelling *programme*, as well as the hint of a residual secondary stress in pronouncing the word (cf. *diagram*, *telegram*).

On balance, therefore, I think one could make as good a case for *programming* as against it.

T. H. CHILTON

Hockessin, Del.

No Need for Genius?

Sir:

Reading J. G. Mason's article on brainstorming (July 14, pp. 155-157), I began wondering whether such substitutes for conventional thought processes are not often necessary because of the kind of people industry prefers. I refer to the "no-geniuses-around-here-just-folks" school of personnel selection.

It seems to me that a lot of little cerebral breezes must be connected in series to produce a brainstorm which, as Mr. Mason admits, might even be an ill wind.

JOHN E. ULLMANN
Consulting Engineer
New York, N. Y.

Sir:

I would like to make a correction on Mr. Mason's article on brainstorming.

In his opening sentence, Mr. Mason gives the Atlas missile credit for placing our first satellite, Explorer I, into orbit. The



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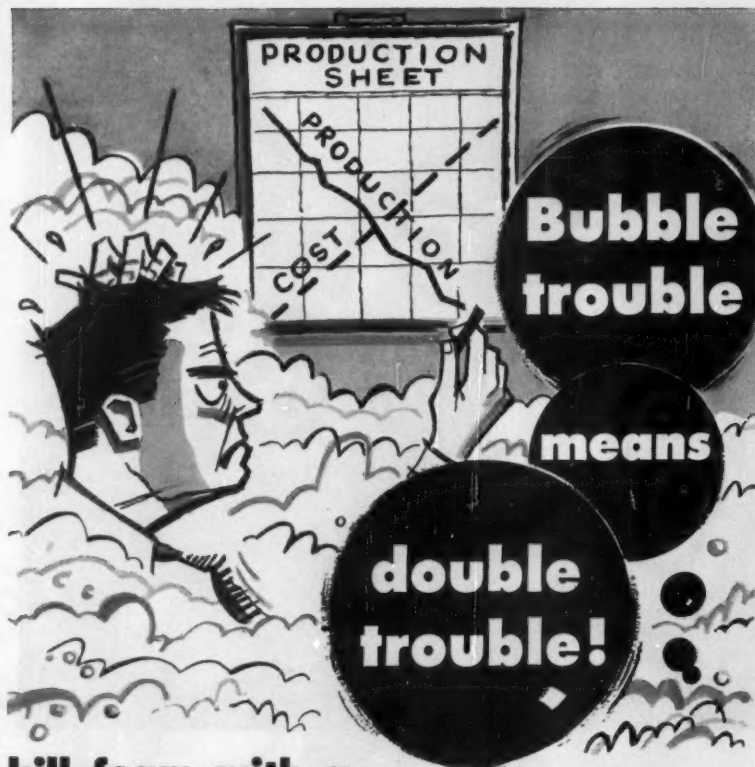


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PRO & CON . . .

missile to be accredited with this historic event is the Army's Jupiter C, a modified Redstone missile, powered by a mighty Rocketdyne booster engine. The Atlas ICBM also uses Rocketdyne engines.

A. K. ALLY
Canoga Park, Calif.



Who Owns Your Knowledge? Sir:

We are attorneys representing several clients in the chemical engineering field, and we were much interested by your article, "Does Your Employer Own Your Knowledge?" (July 28, pp. 127-130). The problems posed by your article directly affect many of our clients.

Your article was very informative and relevant to many problems besetting the engineer and the difficulties which may ensue as a result thereof.

JEROME N. WANSHEL
Counsellor at Law
Larchmont, N. Y.

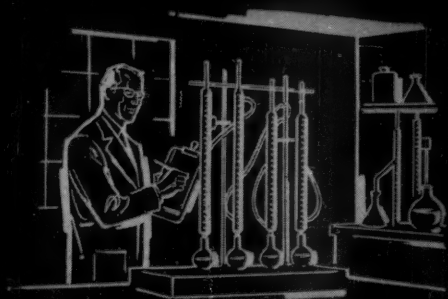
Pro: Equivalent Answers

Sir:

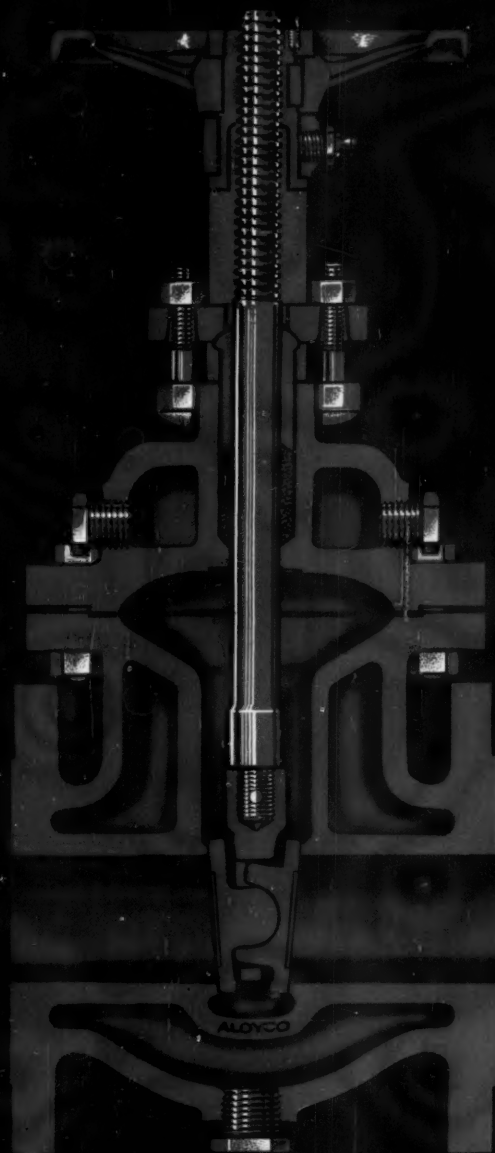
In your July 28 article, "Major Cost Analysis Methods Yield Equivalent Answers" (pp. 116-8), I find a slight error under the heading, *Solution by rate of return method compares receipts against expenses.*

In the very last term of the equation, the numerator should be 2,000 (for Machine B), rather than 3,000 (Machine A).

JOS. R. VONARX
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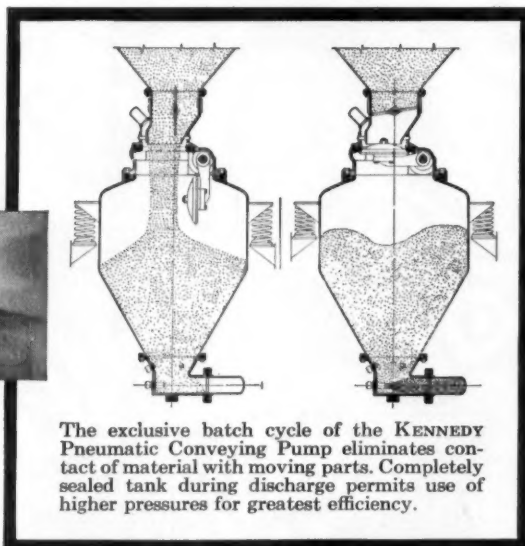
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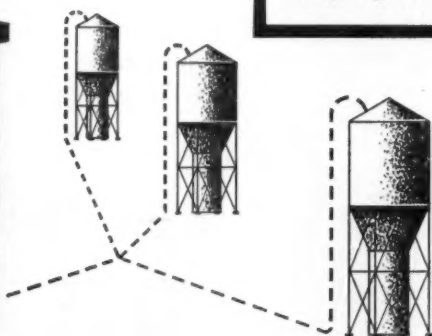
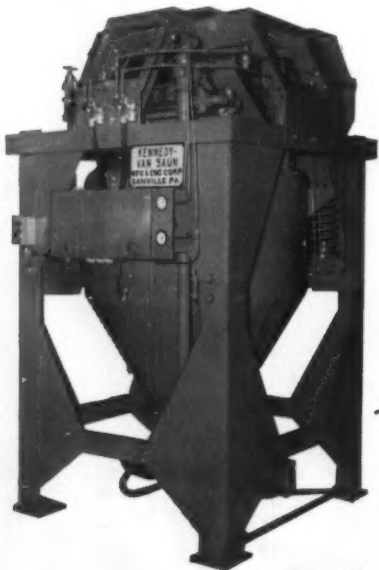
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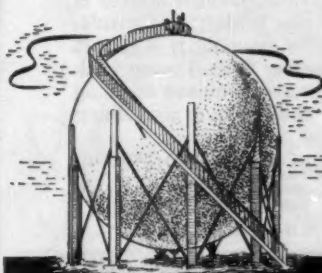
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Chemical Industry—*

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Better, Faster, Cheaper**

AEROFIN CORPORATION

101 Greenway Ave.
Syracuse 3, N. Y.

*Aerofin is sold only by manufacturers of
fan-system apparatus. List on request.*

NUGENT

offers something *Unique* in strainers

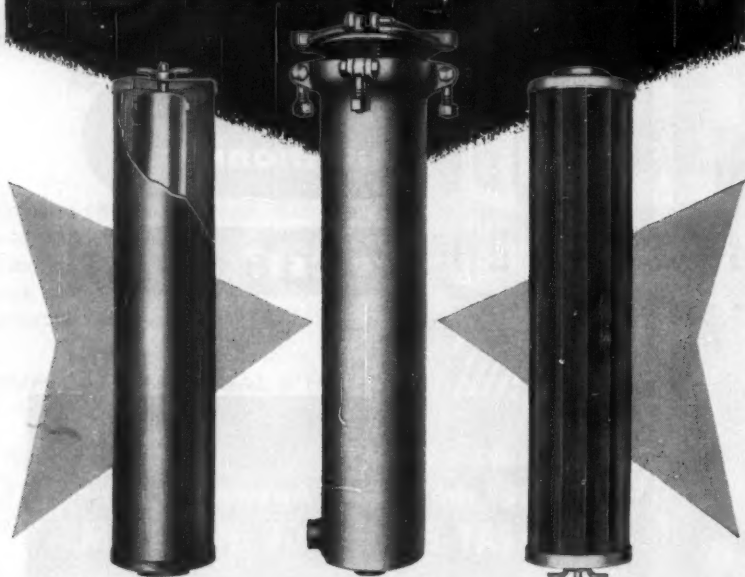


Figure 1554A-4L strainer basket available in brass, steel or stainless steel screen. 8 x 8 to 100 x 100 mesh.

Figure 1554-4L and Figure 1490DD-4L strainer shells are identical. Strainer baskets shown are interchangeable in this model.

Figure 1490CN-4L basket. Star-shape provides 20% more free screen area in this size. Available same metals, mesh as Fig. 1554A.

Nugent pipe line strainers can materially reduce your maintenance labor costs and hold down-time to a minimum. Unlike most strainers of this type, both the Nugent round basket and star-shaped extended area strainers, shown above, catch and hold their accumulation of foreign solids in the interior of the strainer basket.

Dirty liquid, under pressure, enters the strainer through the bottom inlet. It is then propelled upward through the center tube assembly. Emerging at the top, the liquid travels outward and downward, through the mesh of the basket and to the side outlet. In this manner, foreign solids are trapped *inside* the strainer basket which is then easily lifted from the outer shell for cleaning. A clean spare basket may be immediately substituted and the dirty basket cleaned when convenient.

Most other strainers direct the flow of dirty liquid from the exterior to the interior of the basket. Thus, foreign matter is trapped between the outer shell and the basket; not inside. When these dirty baskets are removed for cleaning, it is almost impossible to prevent some foreign matter from flowing back to the inlet and outlet piping. This type also requires scraping and cleaning the interior of the outer shell, a time consuming task that increases down-time.

Nugent strainers can save you time and money. For full details write for Bulletin 6.



REPRESENTATIVES IN
PRINCIPAL CITIES

WM. W. NUGENT & CO., INC.

3458 CLEVELAND STREET, SKOKIE, ILLINOIS

OIL FILTERS • STRAINERS • TELESCOPIC OILERS
OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

READER SERVICE . . .

TECHNICAL

Contents of This Issue

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Chemicals

Anhydrous Caustic Soda is guaranteed not to lump or cake, even in hot, humid weather, because it's Flo-chilled to be free flowing. Details are available.
179 *Wyandotte Chemicals

Antioxidants 4 p. brochure describes the use and effectiveness of its line of agricultural grade antioxidants. Test results of feeding poultry.
184A Eastman Chemical Products

Benzoic Acid "Sodium Benzoate and Benzoic Acid", 8 p., Bulletin 323 describes uses, physical properties, available forms. Uses include foods, cosmetics, drugs.
184B Hooker Chemical Corp.

Catalysts A new study of effect of moisture content on efficiency of metallic chloride catalysts in dimethylol phenol resin cure for butyl rubber is described.
184C Thiokol Chemical Corp.

Chemicals A new General Products list has 12 pages of quick references to all chemicals & services. Other bulletins are also available. Bul. 100-B.
91 *Hooker Chemical Corp.

Defoamer Silicone does the most effective job . . . stamp out foam. Make your own test. Write for free sample of silicone defoamer. No obligation.
180 *Dow Corning Corporation

Diatomite the mineral filler, Celite that adds strength . . . soaks up dirt . . . controls gloss in paints. Available in a wide range of grades.
10-11 *Johns-Manville

Fluorides Company offers a copy of M. C. A. Chemical Safety Data Sheet SD-25 on properties & essential information about hydrofluoric acid, anhydrous & aqueous.
50 *The Harshaw Chemical Co.

* From advertisement, this issue

LITERATURE

E. M. FLYNN

Fluorides, Double......For further information, samples or technical assistance on seven double fluorides. Part of a wide range of fluorides manufactured.
59 *Allied Chemical Corp.

Furfural......To calculate what furfural can do for you, write for information. Physical properties and other data available on your request.
73 *Quaker Oats Co., Chem. Div.

Gas, Industrial......32 p. brochure describes activities of the entire company via sections on products & services of its seven divisions, subsidiaries, affiliates.
185A Chemetron Corp.

Insecticide......Livestock spray insecticide is described in detail in a 6 p. folder. Contains test data on effectiveness against grubs, lice, ticks.
185B Chemagro Corp.

Levulinic Acid......a particularly interesting chemical with polyfunctional characteristics. Acts both as a carboxylic acid & as a ketone. A new Bul. 301-A, is offered.
8-9 *The Quaker Oats Co., Chem. Div.

Lubricants......20 p. bulletin, "Keystone Planned Lubrication," provides a pre-tested, pre-established list of correct lubricants for a number of specific types of equipment.
185C Keystone Lubricating Co.

Plastics......"Products for the Plastic & Allied Industries," 12 p. covers complete line of adhesives, coatings, anti-static agents, cleaners, and lubricants.
185D Chemical Development Corp.

Polyglycols......24 p. "Choosing the Right Polyglycol" covers uses in cosmetics, pharmaceuticals, urethanes, industrial fluids, plasticizers, textiles, leather.
185E Dow Chemical Co.

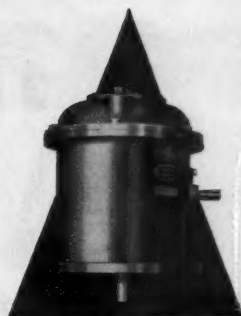
Polyvinylpyrrolidone......4 p. booklet describes table-binding & granulating with Plasdone, pharmaceutical grade PVP. Use in wet granulation, direct compression.
185F General Aniline & Film

Want to build up your files and keep them up-to-date? You can get any publication in this comprehensive guide—free—just for the asking.

It's easy—simply circle item's number on the Reader Service Postcard and mail. Replies will come directly from companies offering the literature.

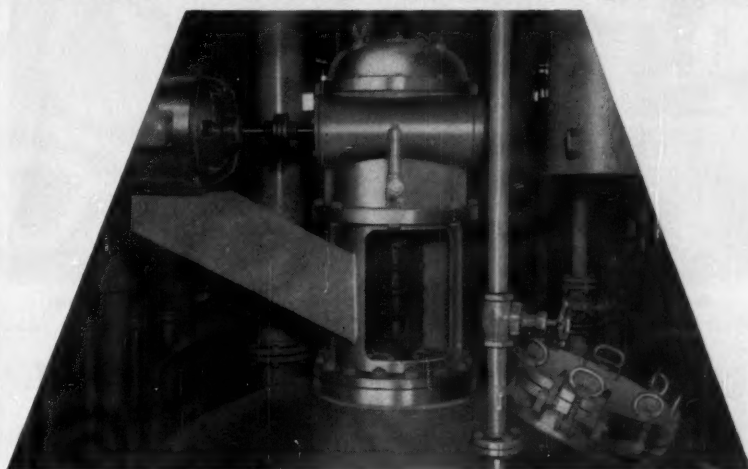
* From advertisement, this issue

CHEMICAL ENGINEERING—September 8, 1958



GET PRODUCT UNIFORMITY FASTER and at LESS COST

... with NETTCO Engineered Agitation!



INCREASE PRODUCTIVITY, lower power costs, and minimize maintenance requirements... with "process-rated" Model WT agitators by Nettco. Standardized components (motor, drive, shaft, stirrer) can be combined to suit your most exacting size, speed, HP or other process specifications. Check the design features of the Model WT tank top agitator...

- Worm gear reduction drives
- Ratios from 3.5:1 to 68:1
- Seven sizes available
- Complete range of speeds
- Minimum moving parts
- Large diameter vertical shaft
- Widely spaced, oversized Timken bearings
- Fully enclosed — dust, fume, moisture-proof
- Splash lubrication, drip-proof design
- Oil-trapped against leakage

Model T units, featuring helical gear trains and worm gears in combination, offer ratios from 6.25:1 to 100:1 in numerous "process-rated" models designed for dependable, economical operation. Ask Nettco agitation engineers for recommendations. Request Bulletin 551 and data sheet from New England Tank & Tower Company, 87 Tileston Street, Everett 49, Mass.



NETTCO
ENGINEERED AGITATION

FREE LITERATURE

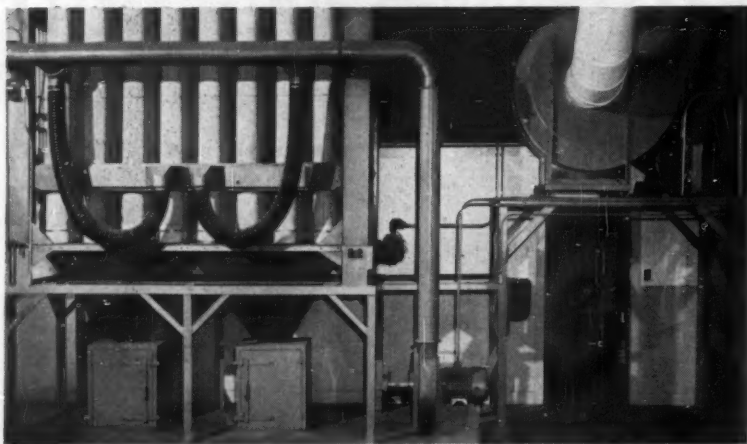
Please send me the following literature:

- | | |
|--|--|
| <input type="checkbox"/> Tank Top Agitators—Bulletin 551 | <input type="checkbox"/> Pipeline-Flomix®—Bulletin 531 |
| <input type="checkbox"/> Portable & Tripod Mixers—Spec. Sheets | <input type="checkbox"/> Side Entering—Bulletin 532 |



DAY

DUST CONTROL NEWS



An unboxed DAY "AC" dust filter* operating in work area of a manufacturing plant.

CUT FUEL COSTS—Return clean, warm, filtered air to work area

If you'll investigate, you'll find nearly all dust filters made are available only as **boxed units** . . . BUT with DAY "AC" filters, housing is optional. Boxed units are necessary when located outside or when placed on suction; UNHOUSED DAY filters can be placed in any convenient plant location. Using DAY UNHOUSED filters means you not only eliminate the cost of filter housing and exhaust piping but cut your fuel bills as well.



DAY "AC" filters are used to clean air in all types of industry . . . for filtering atomic energy dusts and even the air in oxygen manufacturing plants where the elimination of air pollution is most essential. For more information about DAY "AC" dust filters write for Bulletin F-75. It contains useful charts and air engineering data. Write to DAY for your free copy.

*Licensed by H. J. Hersey, Jr.

The DAY Company

SOLD in UNITED STATES by
The DAY SALES Company
836 Third Ave. N.E., Minneapolis 13, Minn.



MADE and SOLD in CANADA by
The DAY Company of Canada Limited
28 Brydon Drive, Rexdale (Toronto) Ontario

For DAY office nearest you refer to our advertisement in Chemical Engineering catalog

EQUIPMENT ONLY OR A COMPLETE SYSTEM

LITERATURE . . .

Soil Fumigants.....8 p. brochure on how fumigants can be used to rid soil of weed seeds, diseases and such pests as nematodes. Photos show application techniques.
186A Stauffer Chemical Co.

Solvent.....High boiling EAK for use in a variety of surface coating formulations. A catalog of solvents, resins & intermediates, "Organic Chemicals" available.
Cover *Shell Chemical Corp.

Thermoplastic.....A copy of "The ABC's of Penton for Corrosion Resistance" is offered. Also, a technical brochure designed for equipment manufacturers.
31 *Hercules Powder Co.

Construction Materials

Alloys, Nickel.....Development & Research Section can help you with your problems of corrosion & high temperature & help select corrective alloys.
118 *International Nickel Co.

Cables, Extension.....Bulletin 1200-3 gives specifications & data on Serv-Rite thermocouple extension cables. The cables, as well as each conductor, is color coded.
L194 *Claud S. Gordon Co.

Chromium Oxides.....are most stable of the green pigments, unaffected by acids, alkalis, vehicles & solvents. Tech. data on 4 pure & 2 hydrated chromium oxides offered.
166 *C. K. Williams & Co.

Coating.....Kangan coating helps eliminate rust from jet fuel systems. This nickel-alloy coating does not chip or break away from machine surfaces.
110 *General American Trans. Corp.

Coatings.....Coal tar or Insul-Mastic gilsonite-asphalt for your plant's corrosion problems. Coatings for weatherproofing or to stop chemical & underground corrosion.
85 *Pittsburgh Coke & Chemical Co.

Coatings, Protective.....Kerpon protects against acids, fumes, caustics, abrasives and heat. It is faster to apply, cuts plant maintenance. Information available.
TR202 *Kerr Chemicals, Inc.

Coatings, Protective.....Tygorust primer provides excellent adhesion to dry or damp rusted steel. Tygon hot spray is ideal equipment coating. Manual for details.
49 *U. S. Stoneware

Concrete.....How heavy duty industrial floors are finished or resurfaced with Cortland emery aggregate is described in 8 p. bulletin 653.
186B Walter Maguire Co.

Edge-Filtering Medium.....Consists of a double-layer, sheet-metal medium with a single pattern of perforations. Perforations on top sheet face solid portion of bottom.
186C Multi-Metal Wire Cloth Co.

Fabricating.....Any type & size of plate work including heavy wall pressure vessels for the petroleum, chemical paper & other industries. Booklet describes facilities.
20-21 *U. S. Steel, Amer. Bridge Div.

* From advertisement, this issue

LITERATURE . . .

Fabrication "Electroforming In The Space Age"—a new, condensed brochure describing the basic principles of fabrication of complicated contoured metal parts.
187A Electroforms, Inc.

Fabrication Steel & alloy plate fabrication from $\frac{1}{4}$ " to 1 $\frac{1}{2}$ ". Experienced and skilled to custom fabricated to your needs or special requirements.
81 *Missouri Boiler & Tank Co.

Insulation A new 4-page folder describes the line of ABCO prefabricated insulation fittings for ell, flange and valve items. Temperature range, sizes, prices.
187B The Aber Co., Inc.

Insulation, Metal-On consists of Thermobestos calcium silicate insulation, a vapor barrier & an all weather protective covering of aluminum. Brochure IN-217A.
24-25 *Johns-Manville

Insulation, Pipe Mineral wool insulation for fast, easy application on steam piping & hot lines up to 1200 F. It's water-repellant, corrosion & fire resistant.
38 *The Eagle-Picher Co.

Lithium Metals Lithium treatment will improve processing of most metals & alloys. Cooperative study of your problems is available on request.
249 *Lithium Corp. of America, Inc.

Materials, High Temperature Booklet, "Norton Refractory Grain" tells about the chemical & physical characteristics & how they react under varying conditions.
71 *Norton Co. Refractories Div.

Metal Corrosive-Resistant Horton-clad offers uniform thickness of clad & backing plate, integral & high strength bond, clean contaminant-free surface. Bulletin.
47 *Chicago Bridge & Iron Co.

Metals Hardening A new 22-page two-color bulletin (No. 242) contains photos describing hardening, carbonitriding and carburizing furnaces.
187C Lindberg Engineering Co.

Packings Chempac Teflon packings in moulded & braided types for pumps & valves. . . in a wide range of flange & envelope-type gaskets . . . in rings, cups, sheets & tapes.
100 *Johns-Manville

Paint Base 2 p. bulletin 108-19 describes new phosphating material that provides a zinc phosphate coating on iron, steel, zinc and cadmium.
187D Turco Products, Inc.

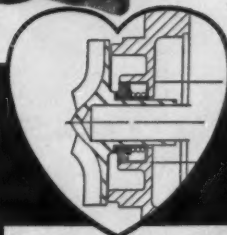
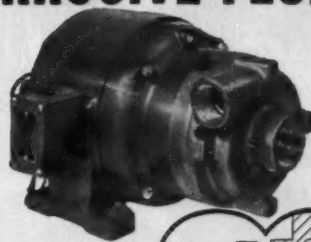
Paints, Latex 16 p. "Why & Where to Use Latex Paints" discusses performance characteristics indoors & outdoors, types, removal; illustrates colors.
187E Dow Chemical Co.

Protective Coatings Portfolio of seven brochures cover vinyls, phenolics, rubbers, acrylics, silicones, furfuryl alcohols, epoxies, paints and enamels.
187F Bisonite Co.

Protective Coatings 4 p. bulletin on outdoor storage pilt protection with a new water-base spray. Included are pictures of the surface crust produced. Bulletin P58-1.
187G Johnson-March Corp.

* From advertisement, this issue

now! greater safety and efficiency in PUMPING CORROSIVE FLUIDS



BART FLEX-SEAL CENTRIFUGAL PUMPS

At last—a full line of pumps specifically designed to handle corrosive and abrasive fluids in the 1 to 80 GPM range, at heads to 70 feet.

No longer need you cut down bigger pumps in range and lose efficiency—or put up with undependable smaller pumps.

Bart pumps have fewer parts to wear or get out of order. Twelve models, each in two materials . . . Type 20 Stainless Steel or Hastelloy C . . . cover almost every application.

Write for catalog and performance curves.

Heart of the BART . . . the exclusive Flex-Seal!

Effectively minimizes a long-provalent basic weakness of centrifugal pump design. Self-adjusting to wear. Needs no external lubrication. Carbon stator with ceramic seat, unexcelled for long wear—or sircon filled Teflon stator with Stellite or Worthite seat for severest corrosive service.

BART MANUFACTURING CORP.
ELECTROFORMING • PIPE LINING & COATING • PLATERS • PUMPS • ENGINEERING DESIGN SERVICES
229 Main St., Belleville 9, New Jersey

WASTE DISPOSAL PROBLEMS?



HAS THE ANSWER . . .

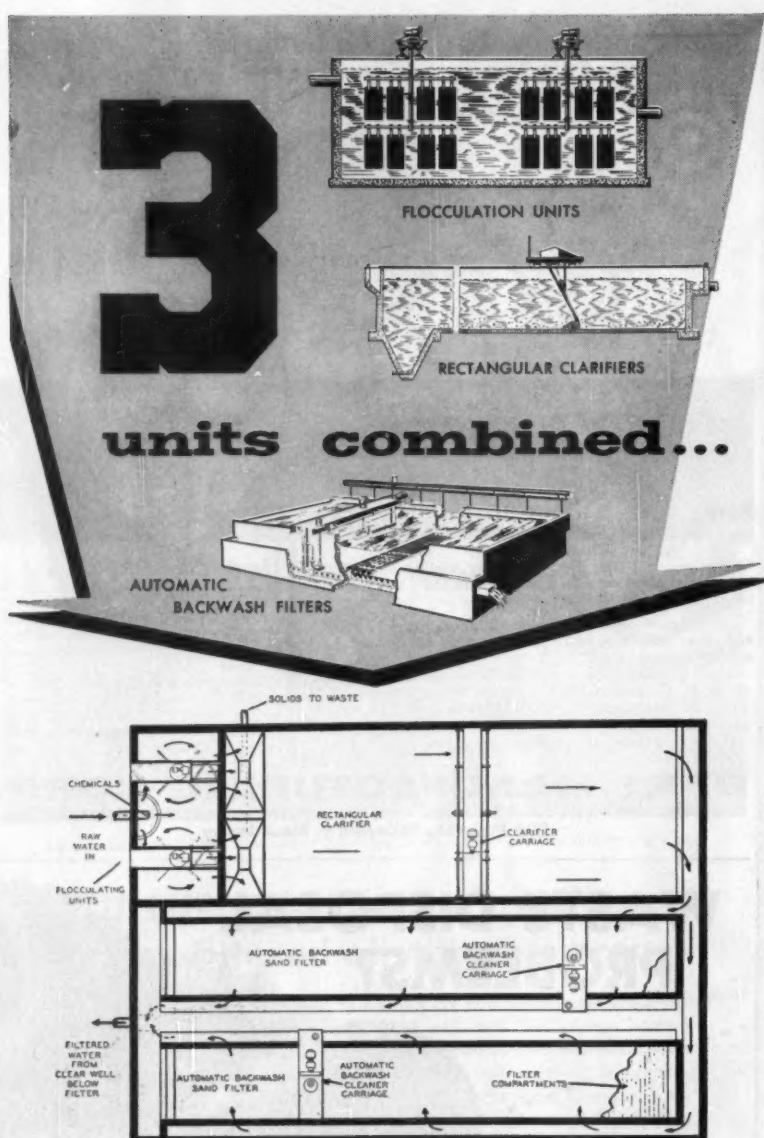
John Zink Waste Disposal Units are custom designed to your specifications, for your individual application. Any size or capacity can be furnished for use in reducing liquid and semi-liquid wastes, or obnoxious gases. Available as a complete unit or burners only. John Zink Waste Disposal Units have been field-proven in process service throughout the world.

*The John Zink research furnace provides ideal test facilities for all custom-design work.

Gas, Oil & Combination Burners / Inert Gas Generators
Air Heaters / Smokeless Field Flares / Mutes

JOHN ZINK CO.

4401 So. Peoria
Tulsa, Oklahoma



...for COMPLETE WATER TREATMENT in Modular Construction

A real "thirst quencher" for industrial and municipal water supplies is the Hardinge equipped water treatment plant—available in unit sizes of from 1 M.G.D. to 5 M.G.D.

Can be furnished complete with automatic plant controls.

Write for full details.

HARDINGE

COMPANY, INCORPORATED

YORK, PENNSYLVANIA • 240 ARCH ST. • Main Office and Works

New York • Toronto • Chicago • Hibbing • Houston • Salt Lake City • San Francisco • Birmingham • Jacksonville Beach

LITERATURE . . .

Refractories Two new bulletins about the properties & applications of our new refractories. Get your free subscriptions to our monthly brochure in addition.

95 *Carborundum Co.

Resins, Fluorocarbon for pipe linings, won't shatter under vibration, can be used at temperatures up to 500°F. Additional technical data available.

17 E. I. du Pont de Nemours & Co.

Rubber, Butyl is the ideal material for wire & power cable, transformers, tapes, busbars & other insulation applications. Resists weather, chemicals, etc. Data.

61 *Enjay Company, Inc.

Rubber Dispersions 4 p. leaflet describes a complete line of chlorinated rubber paste dispersions for industrial coatings, paints and printing inks.

188A Pennsylvania Color & Chemical

Rubber Products Comprehensive 72-page catalog describes and illustrates hose, conveyor belting, plastic pipe, packing and couplings. Specifications listed.

188B Acme Rubber Mfg. Co.

Stainless Steel Tubing Annealing is one important step to assure you ductility & maximum resistance to corrosive agents. Complete details on selection of materials.

R192 *The Standard Tube Co.

Steel Plates Claymont offers a reliable source of quality steel plate products for industry... a full range of fabricating equipment available.

93 *Colorado Fuel & Iron Corp.

Electrical & Mechanical

Contractors Simple solid construction & high interrupting capacity. These contractors make all 600 volt size 4-8 reduced voltage starters dependable performers.

65 *Allis-Chalmers

Equipment, Conduit There are more than 15,000 Conduit items, both explosion-proof & conventional. Full protection against electrically-ignited explosion.

54 *Crouse-Hinds Co.

Gaskets Bulletin AD-104 describes the complete line of spiral wound gaskets for high temperatures & pressures. Available in round, oval, square, diamond, etc. shapes.

22-23a *Garlock Packing Co.

Gearing Worm gearing features interchangeability, high shock load capacity, long life, smooth quiet power, larger ratios, & ease of maintenance. 48-page booklet.

159 *De Laval Steam Turbine Co.

Generators, Steam for high-quality automatic package boilers, 10 to 600 HP. Cuts fuel consumption by 36%. Catalog gives latest information, covers every problem.

45 *Ames Iron Works Inc.

Gyrol Fluid Drive answers virtually every power-transmission need involving adjustable-speed drive. Complete details on type VS, Class 2 & other types is offered.

14-15 *Amer. Standard, Amer. Blower Div.

* From advertisement, this issue

Lighting Fixtures.....20 illustrated pages give details on V-51 convertible vaportight series, parts & accessories. VS-Hand Lamps & WV-Unilights included. Bul. 5-A.
188A Appleton Electric Co.

Lighting Units.....Series AA-51, explosion-proof unit offers new anti-vibration guard. Features, maintenance & installations in illustrated booklet.
189B Appleton Electric Co.

Sealing Rings, Metallic.....Brochure discusses the performance and use of metallic sealing rings. Rings withstand high temperatures, pressures; assure minimum leakage.
189C Koppers Co., Inc.

Seals, Mechanical.....Ranging from types 1 & 2 for services where synthetic rubber is suitable to type 9 to handle any industrial chemical or corrosive. Catalog.
176 *Crane Packing Co.

Steam Turbines.....Design and construction features of steam turbine-generating units rated 2,000 through 16,500 kw. are covered in a new 40-page bulletin.
189D Allis-Chalmers Mfg. Co.

Switch, Quick Connect.....Data Sheet 146 describes a new quick connect switch, ultra-small in size but high in capacity. Single-ply double-throw.
189E Micro Switch

Switches.....Visible blade construction insures safety. Spring loaded fuse clips maintain positive contacts as fuses alternately heat & cool.
87 *Square D Co.

Motors, Fan-Cooled.....confine air stream to surface. Provides extremely efficient cooling & prevents dust & dirt accumulation. Complete details in Bul. 1205.
12 *Fairbanks-Morse & Co.

Motors, Open.....Super-Seal is completely unaffected by moisture, dust, dirt, oil, acids & alkalis. Information available on this & the Silco-Flex.
63 *Allis-Chalmers

Roller Chains.....A new 154-page book contains installation conditions, formulas, charts & diagrams. Also describes lubrication & maintenance for drives & conveyors.
189F Link-Belt Co.

Turbines, Gas.....for catalytic reforming, ethylene production, power generation, etc. Available in sizes of 1150 to 9300 HP. For details, Bulletin 163-1.
43 *Clark Bros. Co.

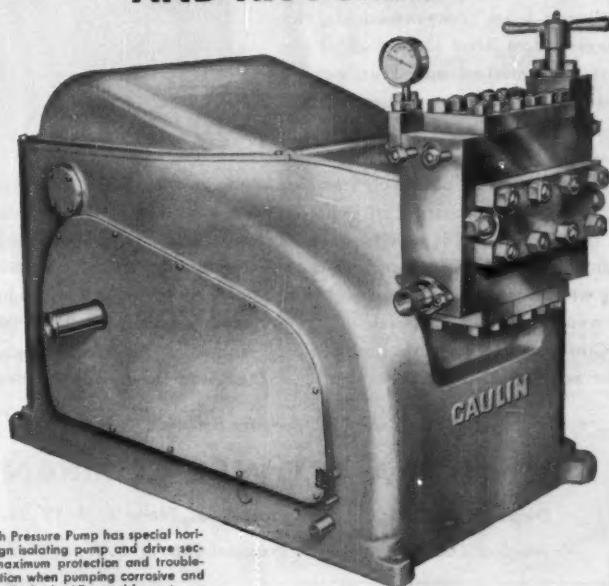
Worm Gear Drive.....Pointing out the advantages of worm gearing, new booklet provides useful general information and pertinent design data.
189G Cleveland Worm & Gear

Handling & Packaging

Cylinders.....for high & low pressure shipment of compressed gas. Uniform weight & capacity simplify filling, handling & record-keeping. Wide range of types.
13 *Pressed Steel Tank Co.

* From advertisement, this issue

PUMP AND CONTROL LIQUIDS, ABRASIVE SLURRIES and VISCOUS FLUIDS WITH GAULIN TRIPLEX AND HX PUMPS



Triplex High Pressure Pump has special horizontal design isolating pump and drive sections, for maximum protection and trouble-free operation when pumping corrosive and hard-to-handle fluids. All wettable parts are stainless steel. Capacities to 6000 gph, pressure to 12,000 psi, temperatures from -90°F to +550°F.

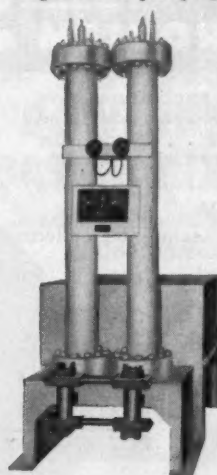
The Gaulin Triplex High Pressure Pump is a rugged, heavy-duty machine for large volume pumping of all types of fluids.

Applications include Spray Drying, Metering, Transfer, Injection, Testing and Hydraulic Pumping. There are over 100 different models available to handle every type of product efficiently and economically. These include sanitary, corrosive, abrasive, viscous and volatile.

The Gaulin HX — Hydraulic Pressure Exchange Pump is a high pressure, high capacity pump specially designed for handling extremely abrasive and corrosive muds, slurries and solutions. It features uniform discharge, slow cycle operation and elimination of all plungers and packing. Handles pressure to 2000 psi, capacities to 120 gpm. Higher capacities on special order. No moving parts are in contact with the product.

Send for GTA Technical Data . . . Complete specifications and technical information contained in GTA† Bulletins. Ask for P-55 on Triplex Pumps and HX-57 on Pressure Exchange Pumps; or request experienced Gaulin Technical Assistance to answer your application.

†Gaulin Technical Assistance.



Write for your set of GTA Bulletins



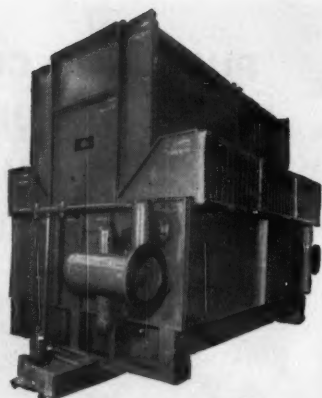
Manton-Gaulin Manufacturing Co., Inc.
71 Garden Street, Everett 49, Mass.

World's largest manufacturer of stainless steel reciprocating, positive displacement, pressure exchange pumps, dispersers, homogenizers and colloid mills.

ECONOMICAL COOLING OF GASES AND COMPRESSED AIR

Cooling gases or cooling and removing moisture from compressed air, the Niagara Aero After Cooler offers the most economical and trustworthy method. Cooling by evaporation in a closed system, it brings the gas or compressed air to a point below the ambient temperature, effectively preventing further condensation of moisture in the air lines. It is a self-contained system, independent of any large cooling water supply, solving the problems of water supply and disposal.

Cooling-water savings and power-cost savings in operation return your



equipment costs in less than two years. New sectional design reduces the first cost, saves you much money in freight, installation labor and upkeep. Niagara Aero After Cooler systems have proven most successful in large plant power and process installations and in air and gas liquefaction applications.

Write for Descriptive Bulletin 130.

NIAGARA BLOWER COMPANY

Dept. CE-9, 405 Lexington Ave., New York 17, N. Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

PRATER CAN Solve YOUR! AIRLOCK FEEDER PROBLEM

More than 2000 different Prater Airlock applications have solved processing requirements for 300 concerns. You'll find there IS a Prater Airlock for your need . . . from low pressure dust control to high pressure pneumatic conveying.



STANDARD DUTY

Primarily adapted for sealing off collectors against air leakage.
Four Sizes . . . 6", 8", 10" and 12".

HEAVY DUTY

For applications involving high pressure Pneumatic Conveying or Volumetric feeding of finely ground materials.

Four Sizes . . . 6", 8", 10" and 12".



BLOW-THRU

For pneumatic conveying systems handling flour or similar fine powder or granular material.
Available for 2", 3" or 4" Conveying Lines.



Send for informative Booklet P-58
"How to Select a Rotary Airlock Feeder"

Foremost Builder of Rotary Airlock Feeders

PRATER PULVERIZER COMPANY

1517 SOUTH 55TH COURT

CHICAGO 50, ILLINOIS

LITERATURE . . .

Drums, Steel. available in a wide range of types & sizes . . . provide complete service to the chemical industry in light & heavy gage classifications. Literature.
26-27 *Republic Steel Corp.

Dry Feeders. Provide accurate feeding of dry chemical reagents for water filtration, sewage disposal and other industrial processes. Eight illustrated pages.
190A Syntrol Co.

Feeders. A full line of process-engineered feeders for dry & liquid materials, volumetric & gravimetric. Bulletin 10-N1 gives complete details.
165 *Omega Machine Co.

Feeders, Airlock. Booklet P-55 describes airlock used for low pressure dust control & high pressure pneumatic conveying. Standard, heavy duty, blow-thru.
B190 *Prater Pulverizer Co.

Hand Trucks. Selector Chart enables the buyer to specify the exact lift truck for his operation through an easy-to-follow listing. Fully illustrated.
190B Lewis-Shepard Products.

Materials Handling Equipment. Booklet describes the design and construction of such steel products as skit units, boxes for roll-over dumping, bar carriers.
190C Republic Steel Corp.

Portable Bag Closer. Requires no installation, supports or plant space. Handles textile & paper bags. Complete Catalog File of bag-closing equipment offered.
190E Dave Fischbein Co.

Scales, Industrial. When you have a problem in weighing, testing, counting, batching, sorting or weight data processing. Information is available.
108 *Toledo Scale Corp.

Vibratory Equipment. A catalog of vibratory bulk materials handling equipment includes descriptions of vibrators, packers, hopper-level switches, flow valves, etc.
190F Syntrol Co.

Heating & Cooling

Cooler. Aero after cooler removes moisture from compressed air. A self-contained system, solving the problems of water supply & disposal. Bul. 130.
T190 *Niagara Blower Company

Collectors, Multi-Wash. performing essential duties in cooling gases & condensing vapors. Detailed information to solve your problems is offered.
L196 *Claude B. Schneible Co.

Dryers, Vacuum Shelf. enable the safe drying of heat or air-sensitive materials which must remain dormant during processing. Other type dryers available. Write.
92 *Stokes Corp.

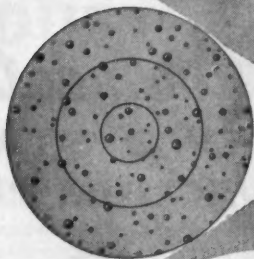
Heat Exchanger. offers the right ratio of surfaces, materials and velocities. Also the right proportion between coil area and depth. Information available.
183 *Aerofin Corp.

(Continued on p. 192)

* From advertisement, this issue

SPRAY NOZZLES

to control LIQUID PARTICLE SIZE
and FIELD DISTRIBUTION
with ACCURACY



For liquid-gas and liquid-solid contact operations to accomplish physical mixing, chemical reactions or heat transfer, Spraying Systems spray nozzles are available to give you any liquid particle size and spray field distribution you may require. Standard spray nozzles are offered in an unusually wide range of types and capacities . . . special designs are gladly supplied when needed.

SPRAYING SYSTEMS CO.

3275 Randolph Street • Bellwood, Ill.

For complete information we invite your inquiry for Catalog 24

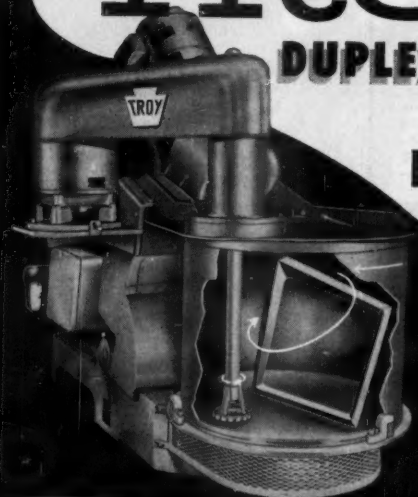


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Produces Finished Product
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Just Published

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By E. B. SHAND

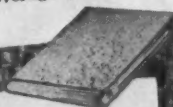
Technical Consultant, Formerly Research Staff Engineer, Corning Glass Works

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Here is a highly useful book on the composition, manufacture, properties, and applications of glass as an engineering material. It gives practical data on the use of glass products in industry, research, and various fields of manufacturing—including electron-tube manufacture, the nuclear field, guided missiles, and the automotive field.

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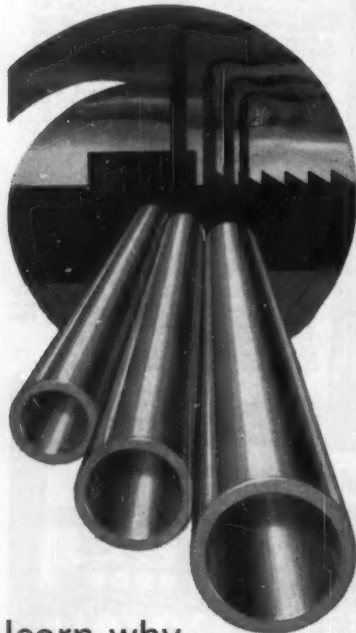
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CE-9-8

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LITERATURE . . .

Heat Exchanger.....Type B suitable for use with most common fluids & is available with either 1/4" or 3/8" O.D. tubes. Mounting brackets are detachable. Catalog 5801-X.
192A Perflex Corporation

Heaters.....A new brochure reports on how to efficiently and economically heat most any gas, vapor or liquid. Describes advantages of indirect-fired heaters.
192B Brown Fintube Co.

Heaters, Dielectric.....Features include: clean wiring arrangements, bakelite standoffs, ceramic coils, sturdy relays. Complete details in Bulletin 15B6431C.
113 *Allis-Chalmers

Furnace Equipment.....for thermal processing of all types of chemicals & minerals ranging from laboratory size 10 lb. batch units to 10,000 ton per day plants. Bul. 233.
39 *Nichols Engineering & Research

Furnace Tubing.....Article explains the factors involved in the selection of the proper furnace tubing for refinery and petrochemical service.
192C Babcock & Wilcox Co.

Refrigeration.....An engineering manual entitled "Mechanical Refrigeration Equipment" is available to Midwestern readers interested in refrigeration system lubrication.
192D Standard Oil Co. (Ind.)

Steam Generator.....A flash-type boiler (30 bhp). steam generator, composed of two 15-bhp. coils and burners, produces dry, saturated steam in 2-3 min. from start.
192E Malsbary Mfg. Co.

Towers, Cooling.....Counterflow Cooling Tower Bul. 4.9.080A is available with information on operation, capacity & a wide variety of factors influencing performance.
109 *J. F. Pritchard & Co.

Traps, Steam.....Write for "Literature Kit 1A" today & get latest bulletins for advice on production planned steam trapped. Big savings in maintenance time.
36 *Sarco Company, Inc.

Vaporizers.....using Dowtherm have been supplied for over 600 installations in sizes ranging from 44,500 Btu/hr to 45,000,000 Btu/hr. Information available.
60 *Foster-Wheeler Corp.

Water Chiller.....Compact, factory-assembled unit installs anywhere in the building, without costly installation. For facts & figures write for catalog EM-213.
86 *York Corp.

Instruments & Controls

Comparators.....for fast, accurate pH, Chlorine, phosphates or nitrates test. Handbook, "Modern pH & Chlorine Control", gives theory & application.
R203 *W. A. Taylor & Co.

Control, Liquid Level.....The 2800 series available with either electric or pneumatic switch action. Bulletin F2800 gives complete information.
101 *Fisher Governor Co.

* From advertisement, this issue
(Continued on p. 194)

the

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Combination

"TWO-STAGE" VACUUM PUMP



The Beach-Russ Combination "Two-Stage" Vacuum Pump gives tops in service at the low micron range.

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Bulletin 95

BEACH-RUSS COMPANY
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**drying
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leading manufacturers* insist
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COLLECTORS**

DUSTEX miniature cyclone tubes, cast of white iron, provide an ultra-hard, cling-free, self-cleaning surface to assure maximum material recovery at a constant, high-speed rate.

DUSTEX patented design prevents condensation within the collector when inlet temperature is above the dew point. Handles temperatures up to 800°F. There are no filters to clog, no sludge to pump. It's virtually maintenance free!

LOW INSTALLATION COST and up to 99.8% efficiency make DUSTEX the perfect collector for spray dryer, rotary dryer or flash dryer processes.

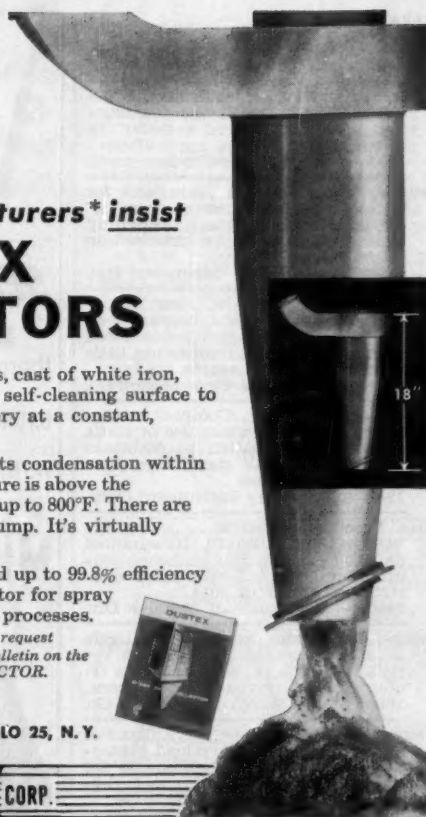
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A sleeve, raised and lowered within a nonmagnetic tube, attracts or releases an Alnico magnet attached to the mercury (or dry contact) switch. Basically, this is Magnetrol.



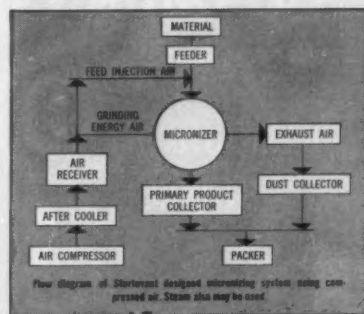
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LIQUID LEVEL CONTROL

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**Sturtevant Micronizers*
Make 325 Mesh Obsolete**



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Sturtevant Micronizers grind and classify in one operation in a single chamber—provide fines in range from 1/2 to 44 microns to meet today's increased product fineness needs. Can handle heat-sensitive materials.

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(15 in. chamber)

No Attritional Heat

Particles in high speed rotation, propelled by compressed air entering shallow chamber at angles to periphery, grind each other by violent impact. Design gives instant accessibility, easy cleaning. No moving parts.

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Eight Models Available

Grinding chambers range from 2 in. diameter laboratory size (1/4 to 1 lb. per hr. capacity) to large 36 in. diameter production size (500 to 4000 lbs. per hr. capacity). For full description, request Bulletin No. 091.

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Sturtevant will help you plan a Fluid-Jet system for your ultra-fine grinding and classifying requirements. Write today.

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Test micronizing of your own material, or production micronizing on contract basis, are part of Sturtevant service. See for yourself the improvement ultra-fine grinding can contribute to your product. Write for full details. STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.



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Italy, Japan, Mexico, Netherlands, Peru, and West Germany

LITERATURE . . .

Meter, Bellows. Specification S292-2 describes in detail the construction and operation of a meter for flow and liquid-level applications.
194A Minneapolis-Honeywell

Control, Liquid Level. available for controlling level changes from 1/4" to 150 ft. Multi-stage switching when desired. Detailed information is available.
BL193 *Magnetrol Inc.

Controller Type VC has exceptional sensitivity & a narrow dead band. Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample.
104 *Republic Flow Meters Co.

Controller, Speed. Compact motor-speed controllers make use of static magnetic amplification to maintain the desired motor speed regardless of load variations.
194B Fidelity Instrument Corp.

Data Processing System. The 123 System is a standard, 100-channel data logger, featuring pinboard programming and all solid state construction. Bulletin 3014.
194C Beckman Systems Div.

Gauge. Master gauge is available in a wider range of corrosion resistant tubes & sockets. Data is offered to cover your specific needs.
198 *Marsh Instrument Co.

Gauge Protection Device. Automatic shut-off valves for overload protection of gauges and instruments are offered for pneumatic and hydraulic systems. Flyer available.
194D Sprague Engineering Corp.

Gauges. Catalog gives complete data on high pressure gauges, gauge cocks, large chamber reflex gauges & heated or cooled gauges.
L197 *Strahman Valves, Inc.

Gauges, Vacuum. A new 28-page brochure describes in detail the GIC-100 & 17 other types in the line of CEC high-vacuum gauges. Bulletin 9-1.
211 *Consolidated Electrodynamics

Instrumentation Electronic Consotrol is a counterpart of its world-famous pneumatic Consotrol line. For the full story on this process control, Bul. 21-10.
94 *The Foxboro Co.

Meters, Bellows. Models are available in many ranges, for both flow & liquid level measurement & control. Details in reference data Catalog C22-1.
119 *Minneapolis-Honeywell

Meters. for hot or cold liquid measurement. Meters measure volumetrically...each rotating cycle of the piston displaces a fixed volume. Literature.
177 *Buffalo Meter Co.

Recorder. New receiver, recorder-controller provides one to four continuous chart records of any measured variable converted to proper signal. Spec. E12-5.
194E Bailey Meter Co.

Temperature Protection Device. New bulletin describes the Alnor Pyrotac, an instrument that is primarily an excess-temperature protective device. Sounds alarm.
194F Illinois Testing Lab.

* From advertisement, this issue

SERV-RITE

thermocouple
extension
wire in

MULTIPAIR CABLE

it
cuts
installation
costs

When four or more pairs of thermocouple extension wires are needed, SERV-RITE thermocouple extension cable will reduce installation costs several ways. It takes considerably less time compared to pulling individual pairs of wires through conduit. Cable also permits the use of much smaller conduit than for the same number of individual wires. It can be hung without conduit, or installed in open trough or by direct burial.

The cable, as well as each conductor, is color coded. Also, each pair of wire is marked for quick identification.

Cables with multiple pairs of four or more conductors of the commonly used types are carried in stock.

Write for Bulletin No. 1200-3
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8146

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Abbé-Engineered Pebble and Ball Mills are available in a complete range of sizes from 40 to 13,000-lb. capacities.

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LITERATURE . . .

Transmitter, Temperature. . . . Low cost temperature measurement within limits of minus 30°F. to plus 1200°F. with simplified adjustments & excellent repeatability. Bul. 98293.
37 *Taylor Instrument Co.

Viscometers. . . . Synchro-Lectric Viscometers or process-mounted Viscometrans, measure, evaluate & control a fluid's ultimate composition or quality in use.
R196 *Brookfield Engineering Lab.

Water Columns. . . . give positive alarm signals. A complete range of pressures & sizes, with screwed, flanged, or welding connections. Data unit gives details.
L203 *Jerguson Gage & Valve Co.

Pipe, Fittings, Valves

Hose, Acid. . . . Handles the highly corrosive acids & chemicals that damage ordinary acid hose. Comes in 2 constructions; with or without wire reinforcement.
212 *B. F. Goodrich Co.

Hose, Stainless Steel. . . . Folder gives full engineering information & tabular data on pressure capabilities, flexibility, suggested usage & help on specific problems.
T173 Allied Metal Hose Company

Equipment. . . . available for high pressure work is described in the new 125-page catalog 407. Valves, pumps, compressors, gages, fittings, tubing, etc.
B173 *American Instrument Co., Inc.

Fire Hose. . . . All-dacron hose won't absorb water, is highly resistant to oils & chemicals. Pressure-tested and available in any color for ready identification.
155 *U. S. Rubber Co.

Fittings, Stainless Steel. . . . regardless of material specifications, size, type or wall thickness. Also furnished in any forgeable material specification.
111 *Ladish Co.

Joints, Rubber Expansion. . . . in piping systems for air conditioning, blower lines, brine tanks, jet condensers, pump lines, circulating water lines, etc. Folder AD-137.
22-23b *Garlock Packing Co.

Nozzles, Spray. . . . to control liquid particle size & field distribution with accuracy. Offered in a wide range of types & capacities. Complete information in Catalog 24.
TL191 *Spraying Systems Co.

O Rings. . . . WS O-Ring Flange Unions are available in 2-bolt & 4-bolt types, according to size & in a variety of materials. For full specifications, Bul. U-1-58.
164 *H. K. Porter Co.

Pipe Fittings. . . . A new 8-page illustrated catalog gives complete data on ductile-iron pipe fittings, including applications, prices, safety factors.
195A Kuhns Bros., Co.

Pipe Schedules. . . . A 17 x 22-in. wall chart of ASA pipe schedules, sizes and weights is available on request. Stiffened top and bottom makes chart hang flat on any wall.
195B Midcontinent Tube

* From advertisement, this issue

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FIG.
19,478

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V-837

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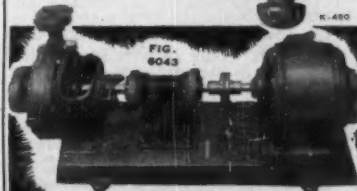


FIG.
6043

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In the industry, Multi-Wash Collectors are now performing essential production duties in cooling gases and condensing vapors. In addition, applications to profitable by-product recovery are commonplace.

Get new production efficiency with Multi-Wash. Write or wire for detailed information that applies to your problem.

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Sweet's File No. Sc

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LITERATURE . . .

Piping. Type S piping systems can end problems of corrosion, erosion & contamination. Liner & housing are in thermal equilibrium. Details in Bul. TS-1A.
16 *Resisto-Flex Corp.

Valves. For use where all-iron or brass-trimmed iron valves are subject to seat corrosion. In 11 sizes, 2 to 18 inches. Technical & specifications in Circular 2313.
83 *Crane Co.

Valves. Flocontrol with V-port disc insures proportional flow throughout the entire lift of the stem. Available in bronze & steel. Details on request.
40 *Manning, Maxwell & Moore, Inc.

Valves. 28 page condensed version of General Catalog available. It has a section on bronze brazed joint valves as well as corrosion resistant nickel-iron line.
196A Ohio Injector Co.

Valves. New general purpose gate & globe types with seal welded bonnet joints. Both identical in dimensions & have 13% stainless steel trim.
122 *Henry Vogt Machine Co.

Valves, Ball. will provide leakproof sealing in long, trouble-free service. Feature quarter-turn opening & closing. For information see Catalog 1000.
97 *W-K-M, ACF Division

Valves, Diaphragm. Maximum flow, minimum turbulence, negligible pressure drop is insured with these Straightway valves. Information available on request.
90 *Grinnell Co.

Valves, Diaphragm. Technical Bul. No. 114 contains more than 250 of the more common chemical services, temperature & pressure specifications on Penton lined valves.
30 *Hills-McCanna Co.

Valves, Gate. in the handling of problem fluids & gases. Now available in 1/4" through 24" sizes. Data on initial & long-range costs & performance will interest you.
44 *Darling Valve & Mfg. Co.

Valves, High-Vacuum. Series ST gate-type, high-vacuum valves feature straight-through, unrestricted flow and a very short flow path; compact construction.
196B F. J. Stokes Corp.

Valve, Leak-Proof. Bulletin describes the manufacturer's multiple-ring-seal gate valve, a new leak-proof unit for aromatics, hydrocarbons and LPG.
196C Vernon Tool Co., Ltd.

Valves, Plug. are tight because the lubricant seals against leakage. A quarter turn of the plug opens or closes the valve. Complete information available.
48 *Walworth

Valves, Stainless Steel. designed for viscous liquids & other fluids difficult to move at room temperature. Other designs for specific applications.
181 *Alloy Steel Products Co.

Thermo-Panels. Bulletin #355 has 52 pages of technical data on thermo panel coils. Bulletin #258 contains prices & design data.
BR202 *Dean Products, Inc.

* From advertisement, this issue

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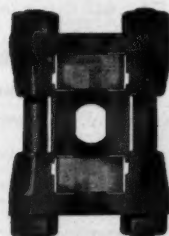
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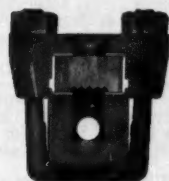
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THROUGHOUT
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Heated or Cooled
Gauges

SEND FOR
COMPLETE
CATALOGUE

STRAHMAN VALVES, Inc.
16 Hudson St., New York 13, U.S.A.



LITERATURE . . .

Process Equipment

Agitators, Tank Top. . . . Model WT is available in 7 sizes with a complete range of speeds. Feature helical gear trains & worm gears. Bulletin 551 and data sheet.

185

*New England Tank & Tower Co.

Blenders Twin-Shell liquid-solids blender easily & thoroughly disperses as little as 0.5% by weight of any liquid into dry solids. A type for every process.

56-67

*Patterson-Kelley Co.

Centrifugals The reverse plowing features eliminate the hazard of accidental plowing during the high speed spinning operation. Details in descriptive data unit #2647.

178

*The Western States Machine Co.

Centrifugals, Filtering Built in a wide range of sizes & types, so whatever your needs may be, there is a B-P unit to do the job. Uniform moisture content product.

99

*Baker Perkins Inc.

Centrifugal Process for continuous acidulation process for tall oil production. Detailed information on this process is available, plus ways of producing quality product.

84

*The De Laval Separator Co.

Collector Around-the-clock dust collection & full-time automatic cleaning...with no interruptions for maintenance. Bul. 52A gives full facts & figures.

107

*Metals Disintegrating Co.

Conveyor, Screw 17 basic screw designs, available in a variety of metals, are included in the line. Also, complete line of troughs, gates, drives, etc. Data 2289.

6

*Link-Belt Co.

Dust Collector Dualaire features are outlined in an 8 page descriptive booklet. Cleaning action is uniform & steady, no variations in gas flow or plant efficiency.

98

*Western Precipitation Corp.

Dust Collectors Miniature cyclone tubes, cast of white iron, provide ultra-hard, cling-free, self-cleaning surface for maximum material recovery. Bul. D-584.

TL193

*Dustex Corp.

Dust Controls Bulletin 917 "Out of the Realm of Dust" presents the full story on dust control installation for use in many diversified industries.

79

*Pangborn Corp.

Dryers Lectrodryers stretch periods between defrosting...out processing slowdowns & extend heat exchanger life. A detailed questionnaire is offered.

35

*Pittsburgh Lectrodryer Co.

Dryers, Gas Units dry to lower dewpoints to give your processes & instruments highest possible protection. For detailed information on your dryer needs, Bul. D-100.

151

*The C. M. Kemp Mfg. Co.

Filter The Retractable Shell type for pressures up to 100 psig, sizes to 3,000 square ft. Clarifies green sodium aluminate liquor. Complete details offered.

204

*Goslin-Birmingham Mfg. Co.

* From advertisement, this issue

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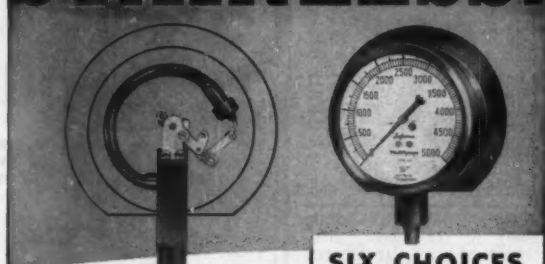
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Firm Name _____

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—from inlet to tip

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403 stainless steel tube with 416 stainless tip and socket.

316 stainless steel tube with alloy steel tip and socket.

316 stainless steel tube with 303 stainless tip and socket.

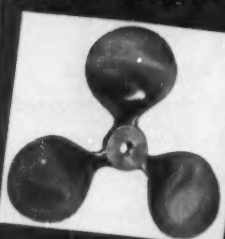
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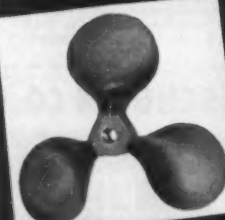
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103 *R. P. Adams Co.

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4 *Bird Machine Co.

Filters . . . Fulflo filters for water and aqueous liquids . . . with genuine honeycomb tubes for true depth filtration. Bulletin GEO-501 gives full information.
198A Commercial Filters Corp.

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32 *Commercial Filters Corp.

Filter Aid . . . Solka-Floc is highly purified, finely divided cellulose. Adsorbs many metals such as iron, copper, other impurities. It makes a stable pre-coat.
168 *Brown Company

Filters, Dust . . . The AC filters are used to clean air in all types of industry. Bulletin F-75 contains useful charts & air engineering data.
186 *The Day Company

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198B Commercial Filters Corp.

Filters, Vertical Pressure . . . Bulletin EF/2 pictorially describes salient features of manufacturers line of vertical pressure filters.
198C The Duiron Co., Inc.

Filtration Equipment . . . Literature available on plate & frame filter presses. Other equipment to meet your filter requirements.
171a T. Shriver & Co., Inc.

Filter Fabrics . . . 2 Booklets, "Fabrics Plus," & "Filter Fabric Facts," answers problems related to fabrics in filtration, rubberizing, coating, laminating, etc.
163 *Wellington Sears Co.

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41 *American Felt Co.

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198D Consolid. Electrodynamics

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R193 *Sturtevant Mill Co.

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(Continued on p. 202)

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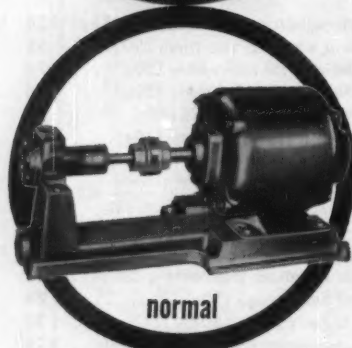
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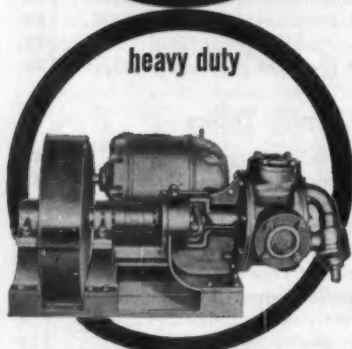
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96 *Sprout-Waldron Co.

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172a *Denver Equipment Co.

Mixers. with new simplified package motor reducer drive. Literature is available on type LWR right angle drive and type LFR with speed ranges 1 to 350 RPM.
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250 *Mixing Equipment Co.

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105 *Read Standard.

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BL191 *Troy Engine & Machine Co.

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184 *Wm. W. Nugent & Co.

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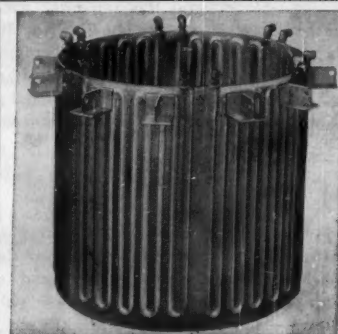
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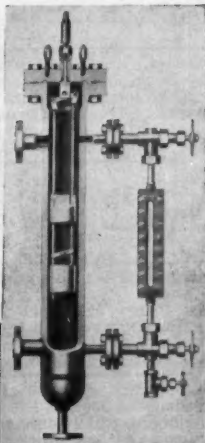


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18-19 Worthington Corp.

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L202 *Viking Pump Co.

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L192 *Beach-Russ Co.

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106 *Food Machinery & Chem. Corp.

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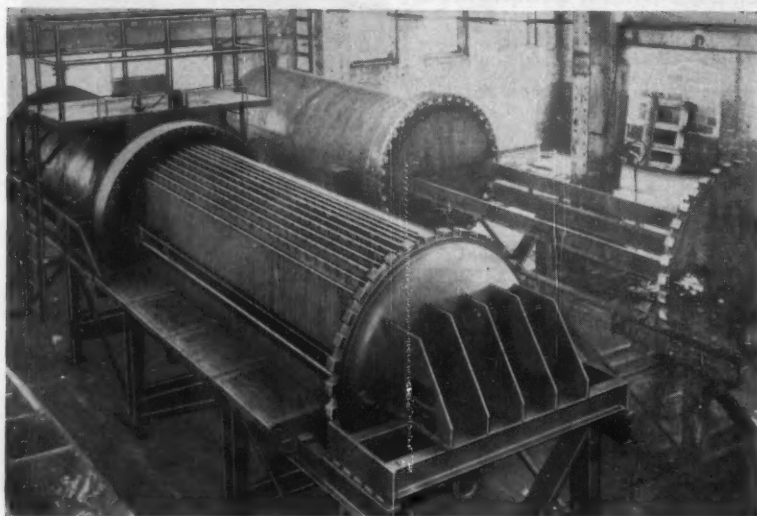
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89 *Armstrong Machine Works.

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Chromatography, Gas. 16 p. Data Sheet DCE/200/258 describes lab instrument which detects by burning exit gases in micro flame and monitoring temperature.

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 5—Pfaudler glass lined reactors 30, 100, 300 gal., jkt. & agit., ASME
 1—T316 SS single effect evaporator, 26 sq. ft., Mojonnier
 1—T316 SS rotary vac. filter, 18" dia. x 12" face, EIMCO

ALSO—tanks, suppository machines, tablet counters, Ertel filter, incubators, motors, pumps, etc.

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THE GELB GIRL—SEPTEMBER 1958

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- 1—Badger type 316 SS heat exchanger, 400 sq. ft.
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- 100—SS pumps from 20 GPM to 1500 GPM, complete with all piping, valves, etc.

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 - 2—Fletcher type 316 SS suspended type jacketed centrifuges, vapor type construction, complete with 32" perforate baskets, plows and explosion proof motors.
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 from, authority; entitled to ob-
 thoritative teachings. 2. Ha-
 beremitory. — au-thor'i-tativ
au-thor'i-ty (ô-thôr'î-tî), n.; pl.
 auctoritas 1. Legal or fish-
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 a particular held; as, the Port a
HAS MORE ENGINEERS mand; —
 peded as, in support of opinic
ON ITS ony; witness. b A prec
PUBLISHING STAFF a book or its author. d Just
THAN ALL OTHER influence of
CHEMICAL PROCESS like. — Syn.
INDUSTRIES auctoritas (ô'thër'î-zâ'shû.
 mission; as, authc
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 precedent; sanction; as, customs
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 a-thor-ized (ô'thër'î-zh), adj. z
 bility. b Sanctioned or approved

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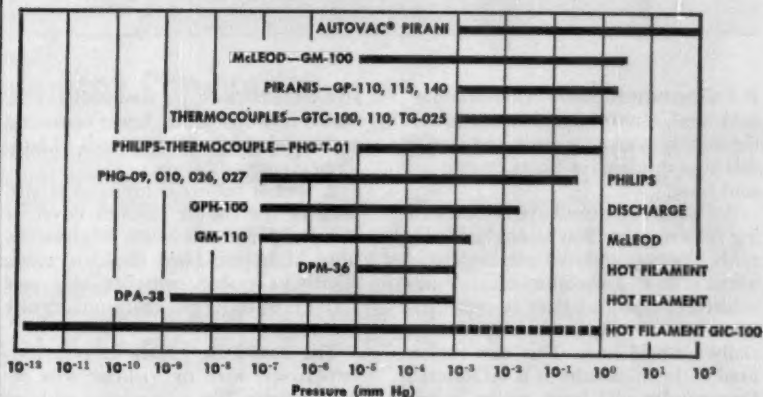
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The accessories available include a one- or two-station thermocouple circuit to read from 1 to 1000 microns. There are provisions for a recorder to read both the thermocouple stations and the ionization tube output.

For more information on the GIC-100 and 17 other types in the line of CEC high-vacuum gauges charted below, write for Bulletin 9-1. This new 28-page brochure describes them all in detail.

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Consolidated Electrodynamics



Rochester Division, Rochester 3, N. Y.

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New B.F. Goodrich acid hose handles highly corrosive acids

B.F. GOODRICH offers "Commander" acid hose, a new hose that can handle the highly corrosive acids and chemicals that quickly eat holes in ordinary acid hose.

For years engineers have been searching for a hose to carry strong oxidizing acids like concentrated sulphuric acid, nitric acid and chromic acid. A new rubber compound that resists these acids has now been developed especially for acid hose. This new rubber, used in the thick tube of B.F. Goodrich Commander acid hose, makes it possible for the hose to last many months or even years in service where ordinary

acid hose lasts only a few weeks. This means less downtime, lower operating costs, and reduces the hazards of handling dangerous acids.

A special rubber compound is also used in the tough, smooth cover of this B.F. Goodrich hose. It gives the hose high resistance to acids, salts, alkalis, abrasion, weather and just about everything else that ruins regular hose.

The new hose comes in two constructions: with or without wire reinforcement. The wire-reinforced hose can be used for both suction and discharge service. It has a heavy spiral

steel wire embedded in the rubber that prevents collapse under full vacuum, increases crush resistance. The hose without wire reinforcement is for pinch-valve service, and can also be used to handle acids which form crust on tube that must be broken off by flexing or pounding hose.

Your B.F. Goodrich distributor has full information on the acid hose described here. And as a factory-trained specialist in rubber he can answer all your questions about all the rubber products B.F. Goodrich makes for industry. *B.F. Goodrich Industrial Products Company, Dept. M-426, Akron 18, Ohio.*

B.F. Goodrich acid hose

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Key Constituent in the Alphabet of Alloys

From A to Z the ally of alloys.

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Aluminum Company of America

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Niagara Falls Smelting & Refining Division CONTINENTAL COPPER & STEEL INDUSTRIES, INC.

Niagara Smelt recommends the use of their "FALLS" 5% Lithium Aluminum Master Alloy to reduce porosity in aluminum die casting alloys. Unexcelled as a deoxidizer and degasifier for copper, bronze and bearing alloys is

their "FALLS" 2% Lithium Copper. It produces a strong, dense, highly electrically conductive casting. And cuprous oxide in copper and copper-base alloys is best deoxidized with Lithium Copper Cartridges.



Handy & Harman

H. & H. supplies brazing alloys of lithium-silver and lithium-silver-copper for joining stainless steel and titanium alloys. Its strong deoxidizing effect on the oxide coating of the metal

increases the alloy's wetting character. Melting point is also reduced, and lithium's self-fluxing effect eliminates the need for chemical fluxes in reducing or inert atmosphere brazing.



Wall Colmonoy Corporation

Wall Colmonoy uses lithium metal to braze titanium and zirconium parts. Li in the form of a metal vapor atmosphere is used as a deoxidizer for oxygen, causing good wetting and flow. The brazing is accomplished at 1400-1600°F., remarkable since the melting point of the silver used is

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Lithium treatment will improve processing of most metals and alloys. New methods of application are broadening its use by industry. We offer cooperative study on your problems. Your request on company or institutional stationery will receive prompt attention.

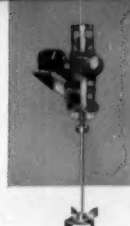


LITHIUM CORPORATION OF AMERICA, INC.

1120 TITLE INSURANCE BUILDING
MINNEAPOLIS 1, MINNESOTA

If you want to cut fluid mixing costs

look inside the tank

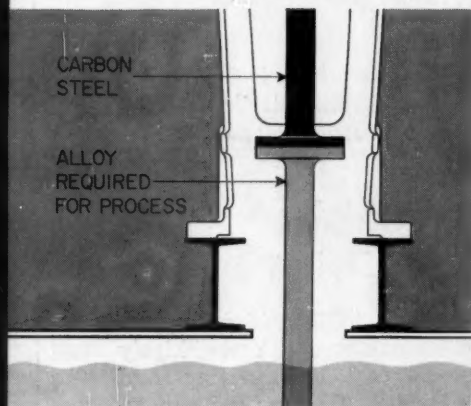


You can make some of your biggest cost reductions *inside* the tank, when you select a mechanical mixer for fluids.

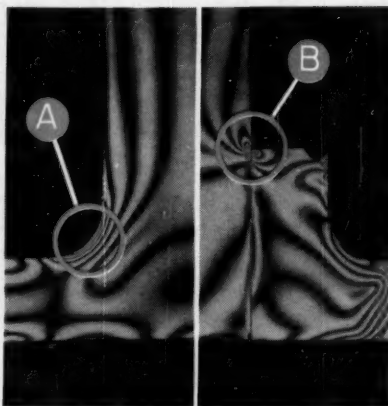
These are *long-term* savings—based on low-cost maintenance, trouble-free service, adaptability to changes in your process, minimum spare-part requirements.

These are the areas where you can *really* save money on fluid mixing. And here are some in-the-tank reasons why you can do it better with LIGHTNIN Mixers than with any other make. For lowest-cost fluid mixing, see your LIGHTNIN representative soon. He's listed in Chemical Engineering Catalog. Or write us direct.

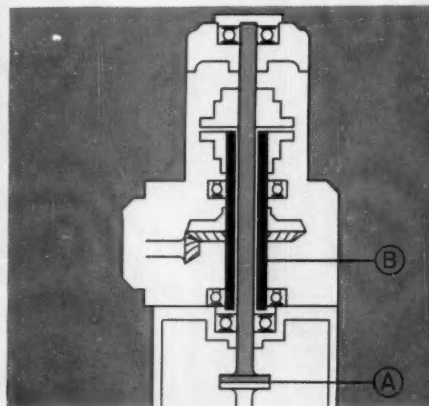
Save 6 ways with these *Lightnin* shaft and impeller refinements



1. Get lower-cost installation, upkeep with two-piece shaft. Standard on open-tank units (available with closed-tank units, too); lower section is alloy required for process; upper section can be inexpensive carbon steel. Rigid coupling has rabbeted joint assuring accurate alignment.

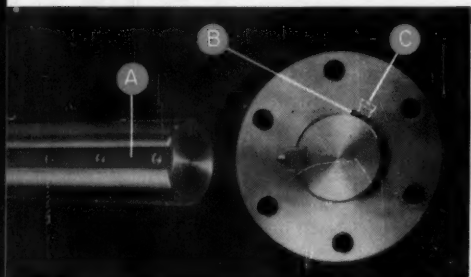


2. You get twice the strength of conventional shaft couplings with LIGHTNIN deep-welded coupling (A). Not one of these couplings has ever failed in service. Polarized light shows how machined and polished radius eliminates stress concentration found in conventional coupling (B).

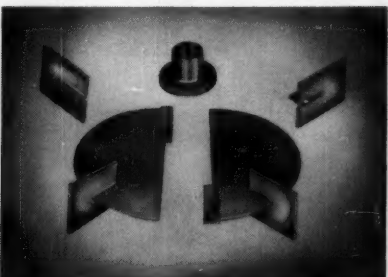


3. No need to disturb gearing if you ever want to replace a LIGHTNIN shaft. Lower shaft is unbolted at (A). Upper shaft slides out of hollow reducer quill* (B). Gears remain untouched—cannot get out of line. When new shaft is installed, shaft alignment is automatic.

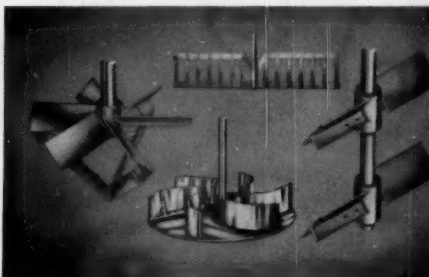
*Patented



4. Save time positioning impellers. Standard 18-inch shaft keyway (A) provides seven positions (more if you want)—saves you cost of special machining. Also note shallow extra keyway (B) for impeller hub setscrew (C). It permits impeller to slide freely, even if shaft is burred.



5. Cut impeller replacement cost with LIGHTNIN all-bolted design. Replace blades without buying a whole new impeller. Blades come off to pass small openings; or impeller can be supplied split, as shown. Same disc takes 4, 5, 6, or 8 blades for easy change in power input.



6. Get the right impeller for your needs. You can handle practically any fluid mixing requirement with a standard LIGHTNIN impeller. But for special jobs, you can get LIGHTNIN impellers made to specification in all machinable materials and with widest choice of coverings.

WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- | | |
|--|--|
| <input type="checkbox"/> Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102) | <input type="checkbox"/> Side entering: 1 to 25 HP (B-104) |
| <input type="checkbox"/> Top entering; propeller types: 1/4 to 3 HP (B-103) | <input type="checkbox"/> Laboratory and small-batch production types (B-112) |
| <input type="checkbox"/> Portable: 1/4 to 3 HP (B-108) | <input type="checkbox"/> Condensed catalog showing all types (B-109) |
| <input type="checkbox"/> Confidential data sheet for figuring your mixer requirements (B-107) | <input type="checkbox"/> Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111) |

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 128-j Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

Lightnin[®]
Mixers

MIXCO fluid mixing specialists